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ANADROMOUS FISHERIES RESEARCH PROGRAM

CAPE FEAR RIVER SYSTEM, PHASE I

By

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ABSTRACT

From 1 July 1975 to 30 June 1977, the various life stages of anadromous species were sampled in the Northeast Cape Fear River, North Carolina. Nursery areas were tentatively delineated for American shad, blueback herring, and alewife. Spawning areas of river herring and striped bass were identified. Growth, abundance, and seaward migration was determined for the anadromous Alosids. Ages of adult American shad were from three to eight. One percent was found to repeat spawning. The sex ratio of those reaching the spawning area was approximately 5:1, male:female. Blueback herring were from age three to seven, alewife: three to six, hickory shad: three to six, and striped bass: two to nine. The abundance of adult American shad and blueback herring was greater during the 1977 run than during the 1976 run. The commercial and recreational fisheries for American shad were investigated and age, spawning frequency, and sex ratio were determined. Fork length of recreationally- and commercially-harvested American shad were compared with those reaching the spawning area, which indicated the fisheries were taking primarily age five females.

INTRODUCTION

The importance of anadromous species to the total commercial finfish landings in North Carolina is shown by statistics of the National Marine Fisheries Service. For the 10-year period 1961 to 1970, anadromous species accounted for an average of 48 percent of the total edible finfish landings (Street and Pate, 1975).

The importance of anadromous species to the recreational fishery of the state is not definitely known, but is considered to be sizable. The annual recreational fish harvest is estimated to be in the millions of pounds.

A total of seven anadromous species enter North Carolina waters, including the striped bass (*Morone saxatilis*), American shad (*Alosa sapidissima*), hickory shad (*A. mediocris*), blueback herring (*A. aestivalis*), alewife (*A. pseudoharengus*), Atlantic sturgeon (*Acipenser oxyrhynchus*), and shortnose sturgeon (*A. brevirostrum*). The latter species may no longer occur in North Carolina.

Anadromous species are considered both recreational and commercial fishes and are taken by standard commercial fishing gear. Significant recreational fisheries employ such devices as bow nets, staff nets, dip nets, gill nets, and seines, as well as hook-and-line fishing. The activity provides both products for public consumption and significant recreational and social events affecting large numbers of resource users.

Several studies of anadromous fish stocks have been completed in North Carolina. Stevenson's 1899 survey was updated in a report on the shad fisheries by Walburg and Nichols (1967). Specific studies have been conducted in the Neuse River (Walburg, 1957; LaPointe, 1958; Pate, 1972). Studies were implemented by the North Carolina Division of Marine Fisheries in the Albemarle Sound region in 1971 and in the Tar-Pamlico River in 1974. Baker (1968) published a reconnaissance survey of anadromous fish stocks in the inland waters of North Carolina. Hassler and others (1955-76) have done considerable work on striped bass in the Roanoke River.

The passage of anadromous fish through the three navigational locks and the spawning and nursery areas of American shad and blueback herring in the Cape Fear River were described by Nichols and Louder (1970). Davis (1967)

estimated the shad run above Lock Number One and evaluated the recreational fishery for shad in the Cape Fear River. Davis and Cheek (1967) reported the distribution, food habits, and growth of juvenile American shad, blueback herring, and alewife in the Cape Fear, Northeast, and Black Rivers. Baker (1968) reported on the recreational harvest of American shad, hickory shad, striped bass, and river herring. Walburg and Nichols (1967) described the shad fishery of the Cape Fear River system. Bayless (1963) discussed the fishery resources of the Northeast Cape Fear River.

Past research related to the anadromous fisheries resources of the Cape Fear Basin has provided some basic information; however, the type of detailed inventory surveys needed for management of the resources have not been undertaken. Such information could only be provided by field-oriented research which is not limited to short-time durations nor to specific portions of the anadromous fish habitat. A detailed field survey of the anadromous fish resources of this system should provide information on spawning and nursery areas, and size and utilization of present stocks. Future demands upon the habitat and fishery resources will require sound management programs for which this information will prove vital.

Major objectives of the project were to determine spawning and nursery areas of all anadromous species; determine growth and movement of juvenile anadromous fishes; determine age and size composition of adults in the commercial and recreational harvests; and determine movement, distribution, and utiliztion of adults within the system.

STUDY AREA

The Northeast Cape Fear River is located in the southeastern coastal plain of North Carolina and is a major branch of the Cape Fear River (Figure 1). Its headwaters are in the town limits of Mt. Olive, and the river meanders southwest for approximately 200 km where it joins the Cape Fear River at Wilmington (Figure 2). The watershed encompasses approximately 453,441 hectares, which includes all of Duplin and Pender Counties and part of New Hanover County.

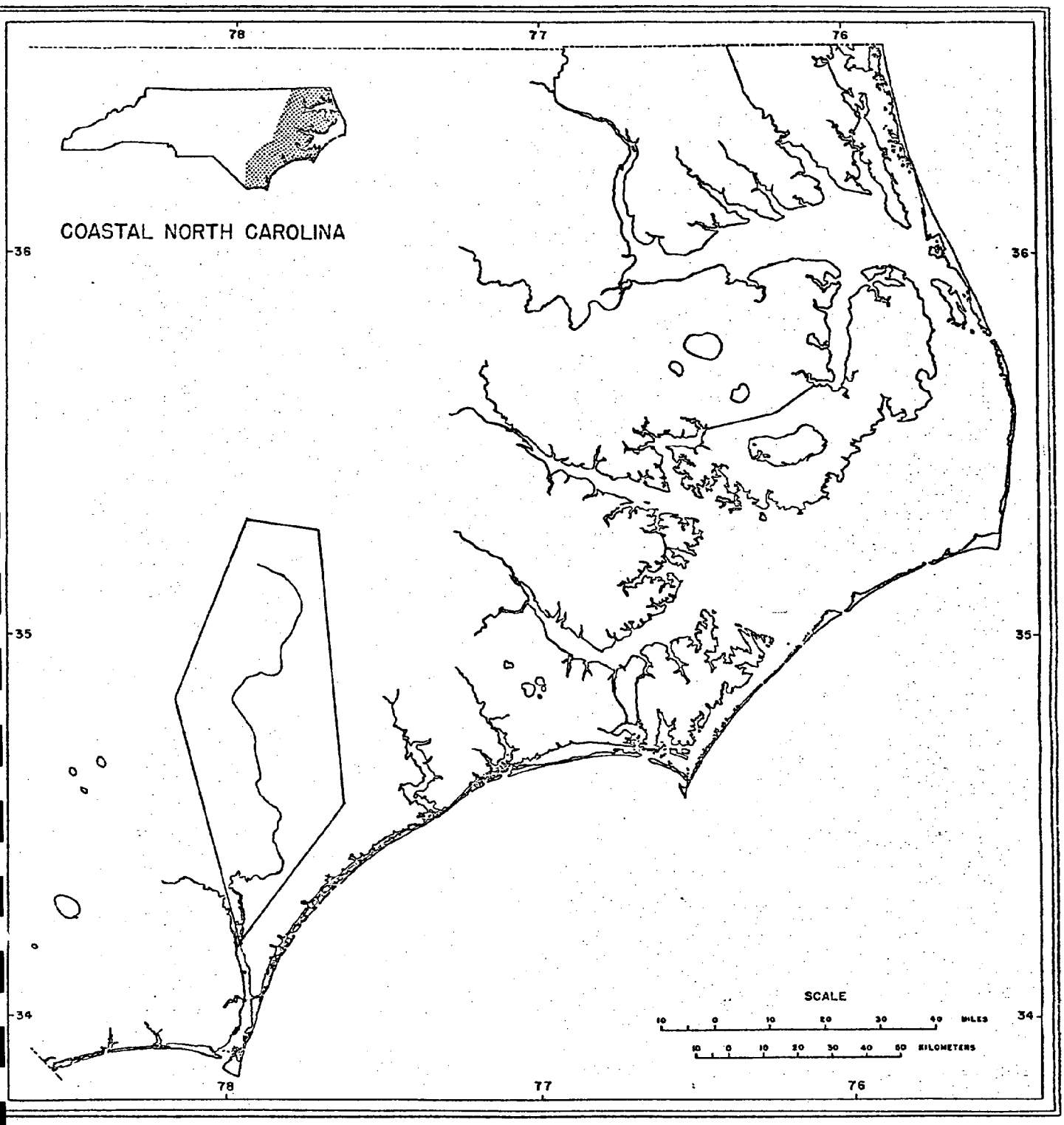


Figure 1.--Location map of the Northeast Cape Fear River

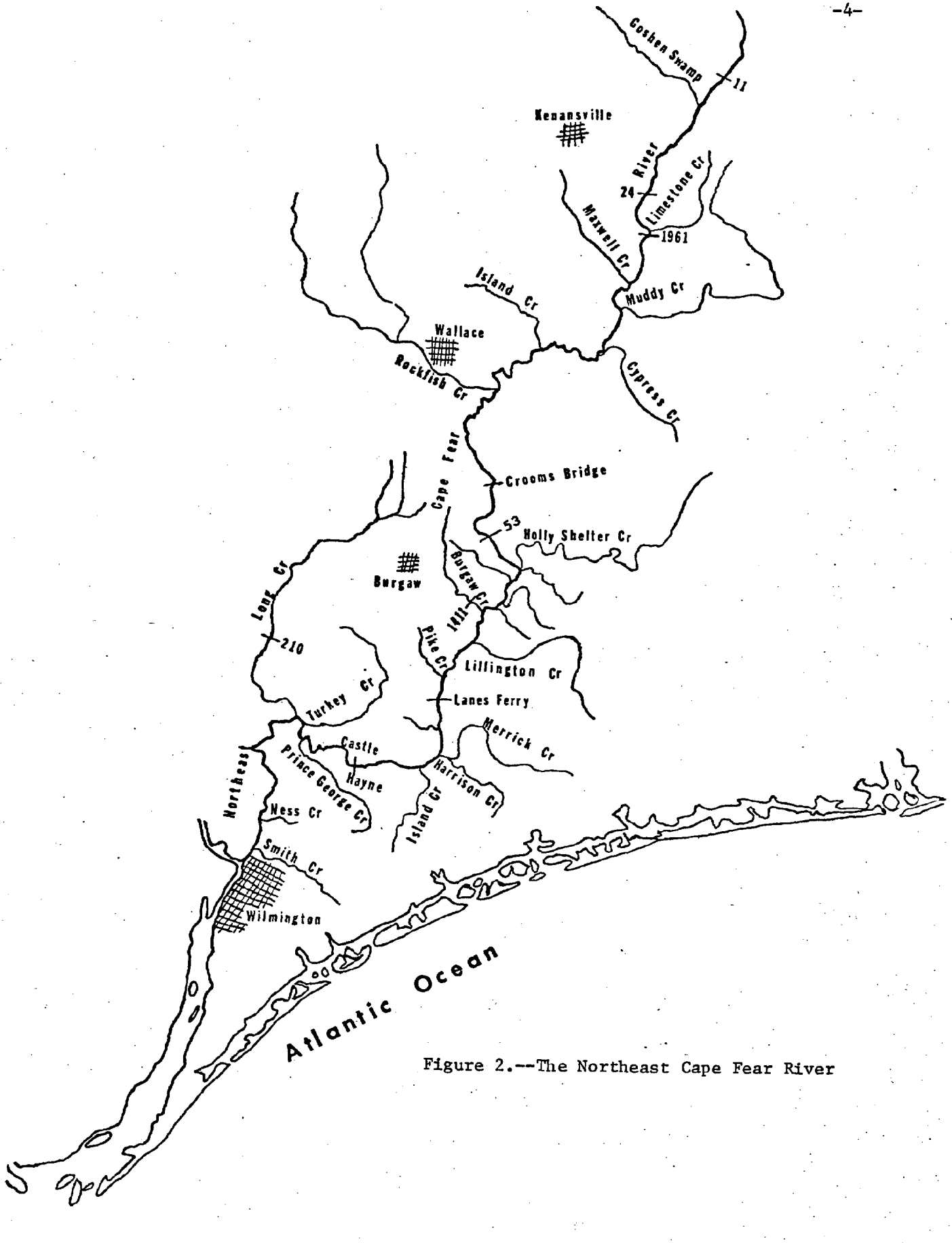


Figure 2.--The Northeast Cape Fear River

The river drains three major swamps: Holly Shelter Swamp, Angola Swamp, and Sandy Run Pocosin. Approximately 80 percent of the watershed is woodland and swamp with vast expanses of wilderness areas. There has been relatively little human impact on the river system. Wallace (population 3,500) is the largest town other than Wilmington. The principal industry is agriculture. Bayless (1963) gave a detailed description of the watershed.

The lower eight km are estuarine with the salt wedge extending up to river km 13 during low flow periods. This area is characterized by brackish and fresh marshes and wooded swamps. It is also the most-developed and industrialized, including the city of Wilmington and its harbor. A 1.7 m tidal variation occurs in this area. Tidal flooding of adjacent marshes and swamps is the basic nutrient source for the lower Cape Fear River estuary. The river in this area is about 400 m wide with relatively high velocities due to tides. The bottom is sand and mud and depth ranges from 4 to 18 m.

Up to Lillington Creek the flood plain is dominated by broad expanses of hardwood swamps. Being tidally influenced, the swamps are flooded and drained twice a day. This flooding action transports nutrients into the river and downstream to the estuary. The river is up to 300 m wide with a very irregular bottom. The average depth is about 6.5 m with occasional holes as much as 21 m deep. These holes are not stagnant because of the relatively swift currents.

The river from Lillington Creek to Holly Shelter Creek has a narrow flood plain with swift currents. Hardwood trees line the bank with some dead water sloughs and flooded swamps off the main channel. The bottom is sandy and ranges in depth from 2 to 13 m.

Above Holly Shelter Creek the river begins to shallow. The depth is generally 1 m with occasional deeper pools. The flow is swift over shallows and slower in deeper pools. The bottom is composed of coarse sand. This section is only about 10 m wide. The banks are very steep with some bluffs being 15 m high. There are numerous small tributaries and sloughs off the river where there is very little flow.

The tributaries are typical swamp drainage streams. They are predominantly slow flowing with dark, acid-stained water. The major tributaries are Smith Creek, Long Creek, Prince George Creek, Island Creek, Harrison Creek, Burgaw Creek, Holly Shelter Creek, Rockfish Creek, and Goshen Swamp (Figure 2).

MATERIALS AND METHODS

Juvenile Survey

A survey of juvenile anadromous fishes was conducted from 1 July 1975 to 31 December 1976. The primary sampling method was a Carolina wing trawl with an 8 m headrope. A 3.2 mm bar mesh tail bag was used. Twenty-six trawl stations primarily sampled the top 3 m of the water column. However, due to the extreme depths, six stations were also sampled on the bottom below Lane's Ferry to capture striped bass and sturgeon (Figure 3). A standard unit-of-effort was a ten-minute tow with the wing trawl.

Due to the shallow depths of the upper river that section was sampled with 18.4 m seines. Bags of 3.2 mm bar mesh were used on the seine to capture all size ranges. There was a total of seven seine stations (Figure 3) with one haul counting as one unit-of-effort.

All alosids were preserved in the field with 10 percent formalin and later sorted to species, weighed, and measured (FL, mm). Captured striped bass and sturgeon were measured and released alive, when possible. Identification of specimens was based on Lippson and Moran (1974). Subsamples of 30 specimens of each species were examined when large samples were encountered. In addition, top and bottom temperatures, depth, bottom type, and river stage were noted at each station each month.

Adult Survey

Adult anadromous fish were sampled from January through May 1976 and 1977. Sampling was conducted primarily with various mesh gill nets. Surface nets of 45.9 m, 18.4 m, and 9.2 m lengths, with meshes of 6.4 cm, 7.0 cm, 8.3 cm, 10.2 cm, 12.4 cm, 13.3 cm, 14.0 cm, and 15.4 cm stretched were used. They were anchored and left for 24 hours. The larger meshes were set in mid-river to catch shad while small mesh nets were set along the edge for river herring. The river was divided into three sampling areas. They are as follow: Area 1 - mouth to Lane's Ferry, Area 2 - Lane's Ferry to Crooms' Bridge, and Area 3 - Crooms' Bridge to NC 11 (Figure 4). Each area was sampled at least once a month, and

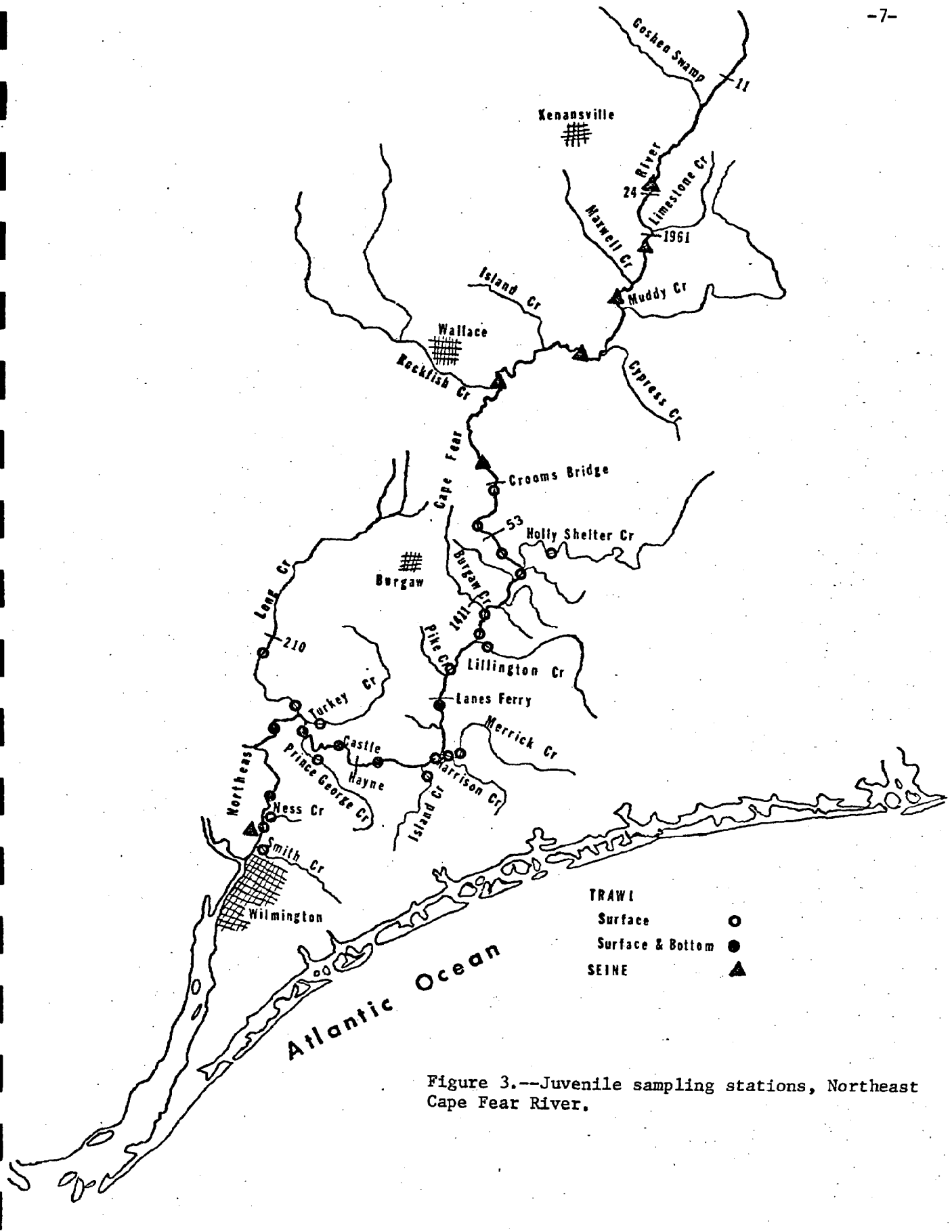


Figure 3.--Juvenile sampling stations, Northeast Cape Fear River.

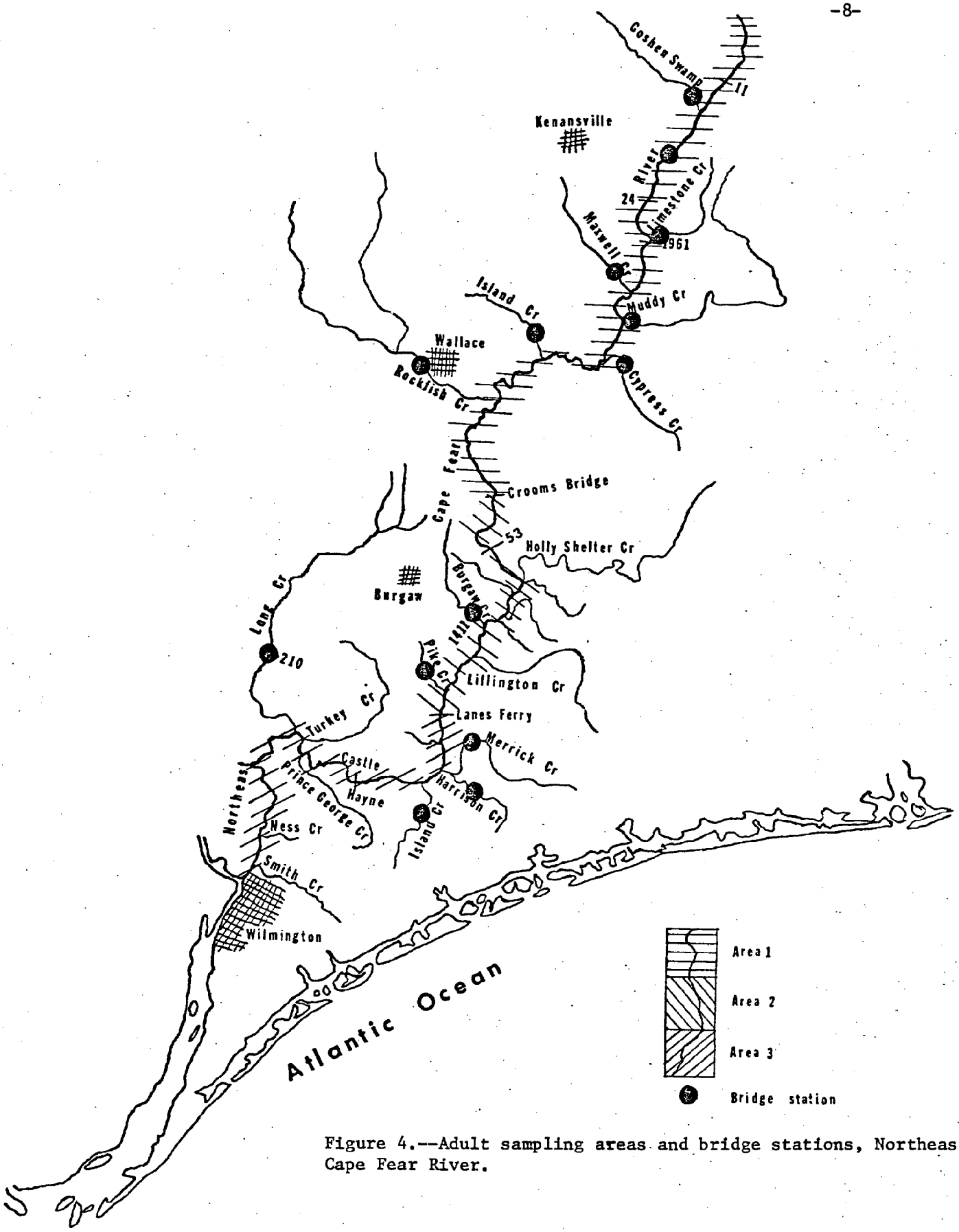


Figure 4.--Adult sampling areas and bridge stations, Northeast Cape Fear River.

for the most part were sampled twice a month. Each major tributary was sampled a minimum of twice per month. Gill nets were also set at bridges to determine adult distribution (Figure 4). Equal efforts of each mesh size was used to sample all segments of the population equally. One standard fishing unit was considered to be 91.4 m of net set for 24 hours. Catch per effort (C/e) of herring was based on the amount of small mesh nets set, shad on large mesh nets, and striped bass on total units.

From 22 March through 14 May 1976 and from 7 March through 25 April 1977, a haul seine was used to sample adults. The seine was located about 8 km below the NC 53 bridge (Figure 27). The seine was 68.6 m long, with 6.4 cm stretched mesh. It was operated one day per week during the sampling periods except the week of 14 March 1977 when high water prevented sampling.

All adults captured in gill nets and haul seines were weighed, measured (FL, mm), sexed, and spawning condition noted as immature, mature, ripe, running-ripe, and spent. In addition, scales were taken from the left side below the dorsal fin. Aging was done by the annuli and spawning mark method with the scale edge counted as a yearmark as described by Cating (1953), Beal (1968), and Street and Adams (1969). Several clear scales from each fish were read with a binocular microscope. Two readings were made, and those disagreeing were discarded.

Spawning Area Survey

A survey of spawning areas was conducted from 14 March through 22 May 1976 and from 20 March through 14 May 1977. Half meter plankton nets with #00 mesh were used to sample eggs and larvae. Samples were taken twice a month at each juvenile station (Figure 5). All samples were towed or anchored for five minutes at the surface, and where possible, for five minutes close to the bottom depending upon the amount of current. In addition, random samples were taken where spawning was suspected to occur. Samples were taken twice monthly at each gill net bridge station. A five-minute tow with the plankton net was considered to be one unit of effort. Samples were fixed in the field with 10 percent formalin and later preserved in a 2 percent solution. Finally they were sorted and identified. Identification was based on Lippson and Moran (1974) and Chambers (1969). Alewife and blueback herring eggs and prolarvae were combined

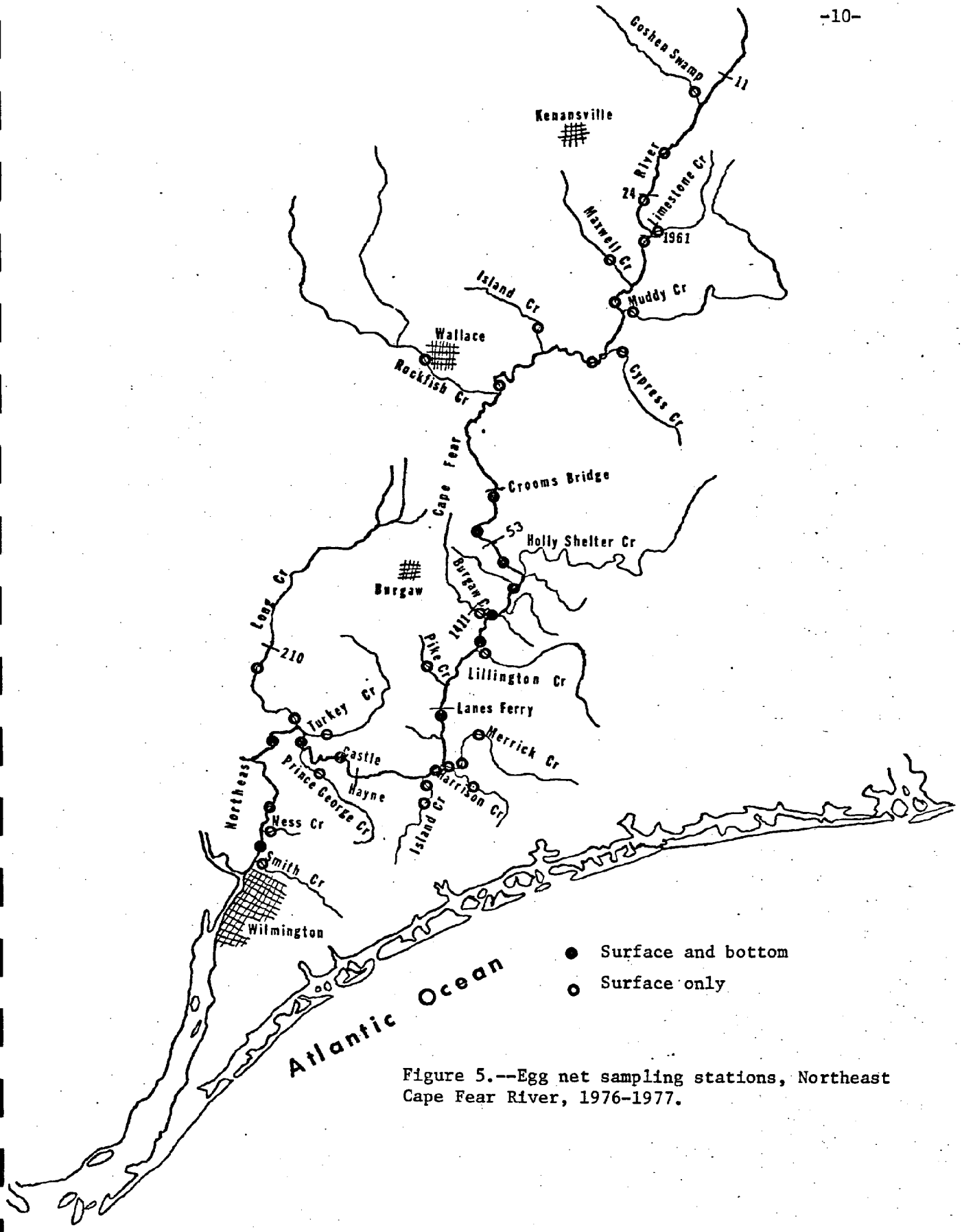


Figure 5.--Egg net sampling stations, Northeast Cape Fear River, 1976-1977.

and called river herring due to the difficulty in distinguishing between the two. The occurrence of a running-ripe female was also considered to be evidence of a spawning area. Visual observation of spawning was also noted.

Commercial and Recreational Harvest

Harvest sampling was conducted at fish markets and fishermen's houses, primarily on weekends when most fishing occurred. Sampling was primarily limited to drift net catches due to an inability to locate and obtain samples from anchor gill net fishermen. Samples were taken whenever possible from fishermen on the river and at landings. These were considered to be unculled. Measurements (FL) were taken along with sex and scales for aging.

Tagging

Tagging of striped bass and sturgeon was done whenever a specimen was found. Fish were tagged with Floy Dart tags. Specimens were obtained primarily from the haul seine and gill nets. Measurements and striped bass scales were taken from tagged fish. Rewards of up to $25 were offered for the return of tags and information. Tagging was widely publicized with posters and in local newspapers.

RESULTS AND DISCUSSION

Juvenile Survey

A total of 3,528 juvenile fishes, including blueback herring (2,739), alewife (313), American shad (427), hickory shad (17), striped bass (27) and Atlantic sturgeon (5) were captured in Northeast Cape Fear River during the study period (Table 1). Surface sampling with the wing trawl was found to be effective in capturing anadromous clupeids. Due to the depth of the river, striped bass and sturgeons could not be sampled at the surface because of their relatively demersal habits. As a result, samples were taken at the river bottom in those areas free of hangs. Due to the limited area sampled, a true picture of the juvenile distribution of striped bass and sturgeon was not found.

TABLE 1.--Relative abundance of juvenile anadromous fish by gear for the 1975-1976 classes, Northeast Cape Fear River.

Method	Wing trawl (surface)		Wing trawl (bottom)		Seine		Total number	
Year Class	1975	1976	1975	1976	1975	1976	1975	1976
Effort	187	175	37	42	44	43		
American shad								
Catch	178	79			151	19	329	98
C/e	0.95	0.45			3.43	0.44		
Blueback herring								
Catch	629	1762			58	290	687	2052
C/e	3.36	10.07			1.32	6.74		
Alewife								
Catch	127	185				1	127	186
C/e	0.68	1.06				0.02		
Hickory shad								
Catch		14				3		17
C/e		0.08				0.07		
Striped bass								
Catch			16	2		9	16	11
C/e			0.43	0.05		0.21		
Atlantic sturgeon								
Catch			3	2			3	2
C/e			0.08	0.05				
						Total	1162	2366

The relative abundance of each species for each sampling method and year class is shown in Table 1, excluding February through May 1976 samples, when no anadromous juveniles were captured.

American shad

Juvenile American shad were found throughout the river system up to the SSR 1961 bridge (Figure 6). Davis and Cheek (1967) reported that young shad were found up to NC 24 bridge. During both years there appeared to be two major nursery concentrations - from the river mouth to Lane's Ferry, and from Cypress Creek to SSR 1961. Only an occasional individual was found in between. In addition to the major concentrations found in the river, juveniles were also found in certain tributaries. Table 2 shows their relative abundance in the tributaries compared to the river. Certain tributaries had a higher C/e value than the river, but, the overall C/e was greater in the river than in the tributaries. This indicated that although young shad use the tributaries, their major nursery is in the main stem of the river.

Juvenile American shad were found in the river until December 1975 and 1976. Their greatest occurrence was during August of both years with a seaward migration occurring during September and October (Figure 7) when the water temperature dropped. Those fish in the river after October were found in the lower part. The largest specimen observed during the study period was 83 mm (FL), slightly smaller than observed by Davis and Cheek (1967) during 1964-65 for the same river. Figure 8 shows the mean monthly fork length of juvenile American shad for the 1975-76 year classes.

Table 1 indicates the 1976 year class was significantly less abundant than the 1975. The low density of juvenile American shad is probably a result of the low adult run observed during the spring of 1976.

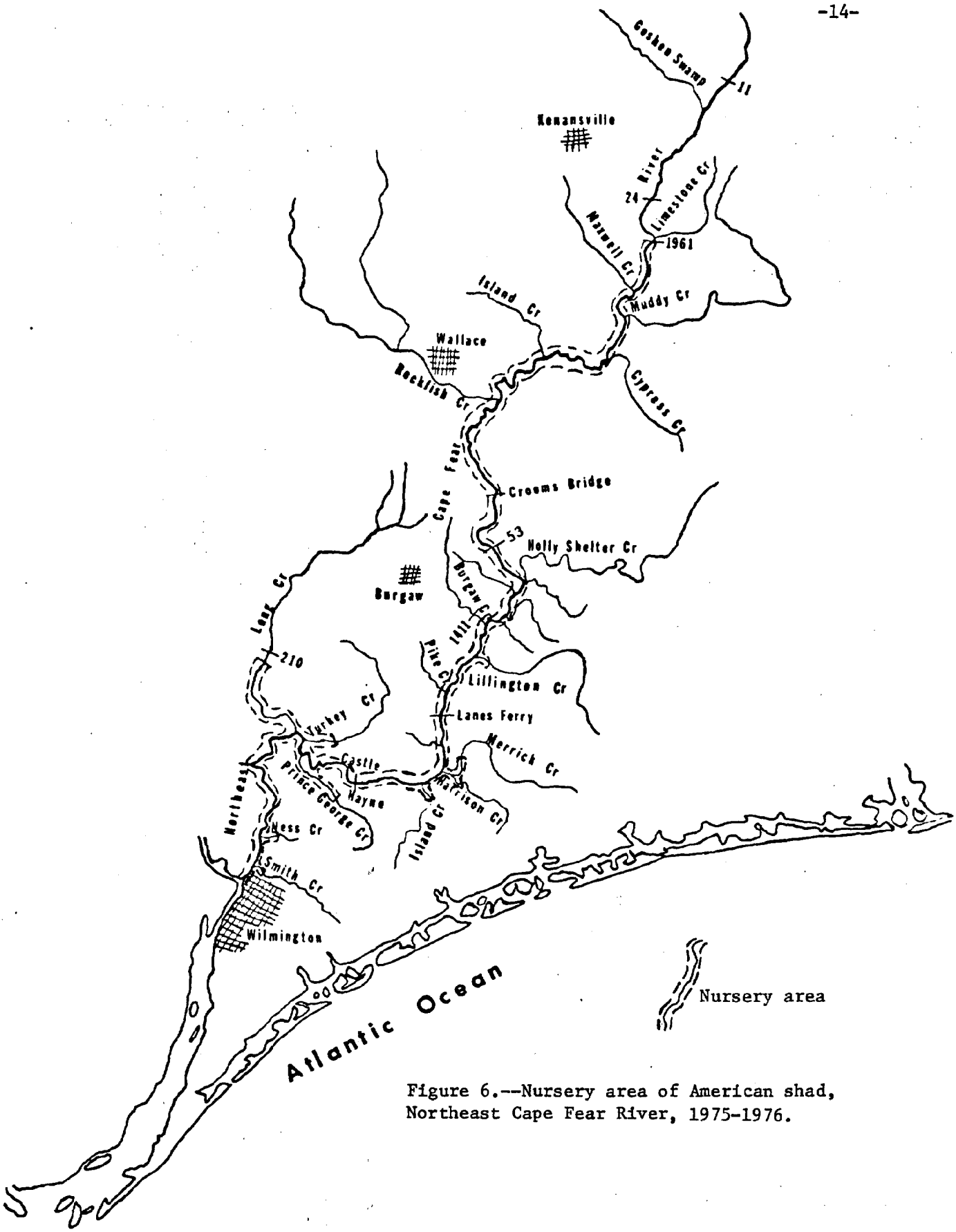


Figure 6.--Nursery area of American shad, Northeast Cape Fear River, 1975-1976.

TABLE 2.-- Relative abundance of juvenile anadromous clupeids in the tributaries as compared to the Northeast Cape Fear River, 1975-1976.

Year Class	American shad				Blueback herring				Alewife			
	1975		1976		1975		1976		1975		1976	
	Catch	C/e	Catch	C/e	Catch	C/e	Catch	C/e	Catch	C/e	Catch	C/e
River	145	1.48	59	0.66	107	1.09	551	6.19	79	0.81	100	1.12
Smith Creek	5	0.83	5	0.83	25	3.57	178	29.67	3	0.43	2	0.33
Ness Creek	9	1.50	1	0.17	336	56.0	237	39.50	29	4.83	2	0.33
Long Creek	7	0.64	2	0.17	7	0.58	155	12.92	5	0.42	38	3.17
Turkey Creek	11	1.83	5	0.83	73	12.17	208	34.67	4	0.67	29	4.83
Prince George Creek	4	0.67	1	0.17	9	1.50	103	17.17	2	0.33	0	0
Island Creek	1	0.17	1	0.17	11	1.83	299	49.83	0	0	5	0.83
Harrison Creek	1	0.17	5	0.83	5	0.83	11	1.83	0	0	4	0.67
Merrick Creek	2	0.40	0	0	46	11.50	20	3.33	2	0.50	5	0.83
Lillington Creek	1	0.17	0	0	1	0.17	0	0	1	0.17	0	0
TOTAL Tributaries	41	0.73	20	0.37	513	9.16	1211	22.43	46	0.82	85	1.57

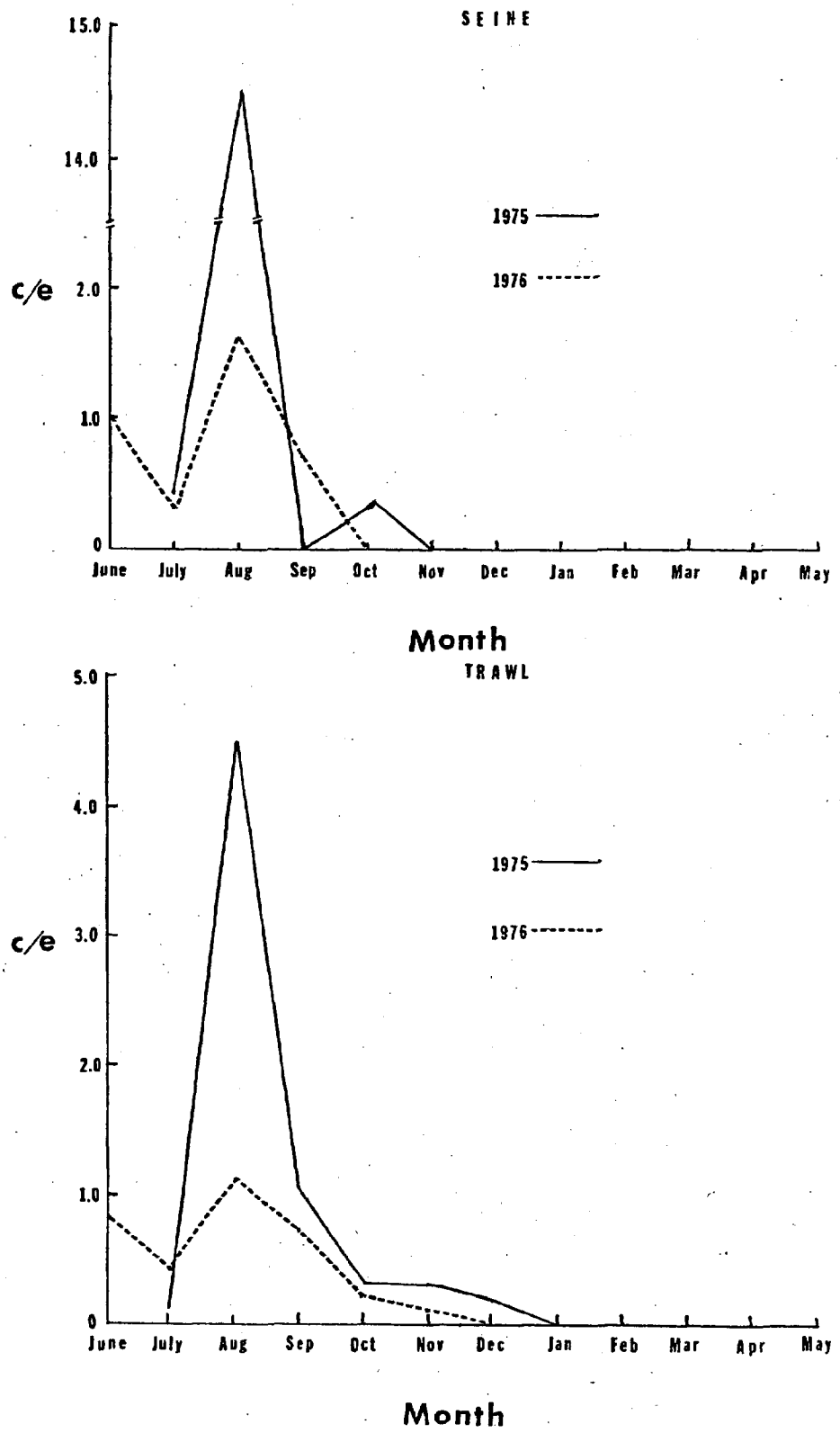


Figure 7.--Monthly catch per effort of juvenile American shad, Northeast Cape Fear River, 1975-1976.

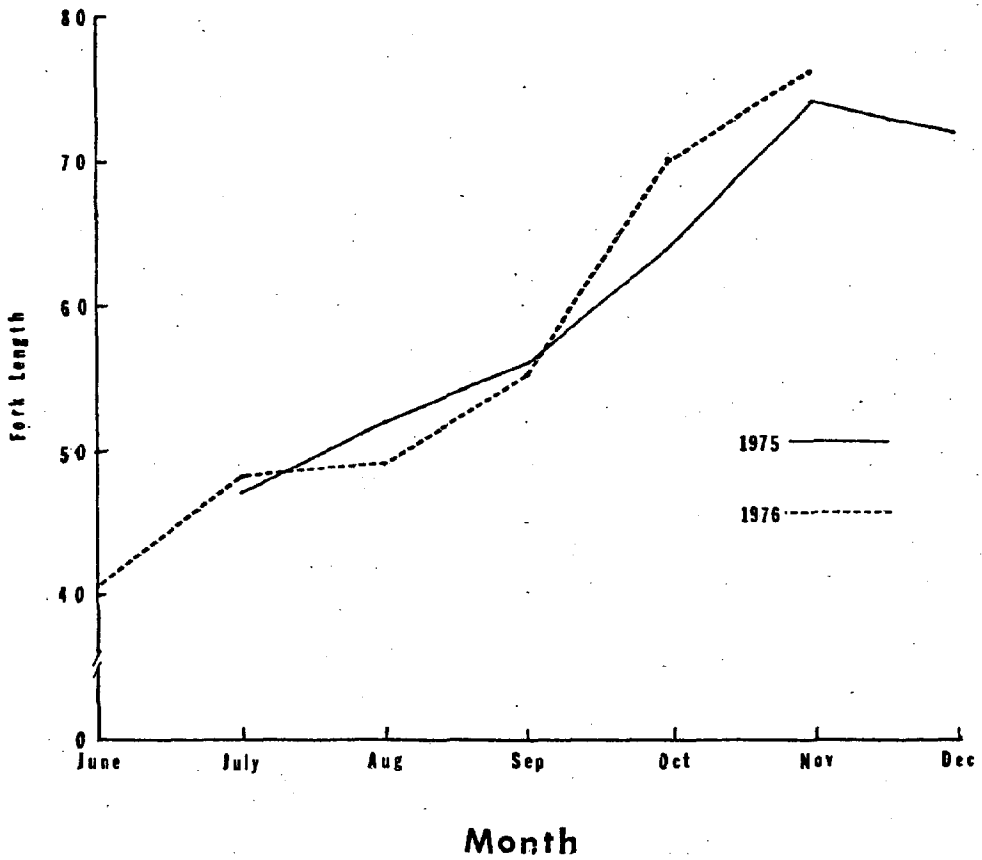


Figure 8.--Mean monthly fork length of juvenile American shad, Northeast Cape Fear River, 1975-1976.

Blueback herring

Juvenile blueback herring were found from July through December 1975 and from June through November 1976. They were caught throughout the river system up to Holly Shelter Creek. During 1976 they were also found approximately 8 km above Crooms' Bridge (Figure 9). They were also found in most of the major tributaries. Table 2 shows the relative abundance of blueback in each tributary. In addition, other sample methods showed them to occur in Burgaw and Holly Shelter Creeks. Unlike American shad, blueback herring were more abundant in the tributaries than the river during both years.

The peak occurance of juvenile blueback was in November during 1975 and in September and October of 1976 (Figure 10). This was probably due to the increased availability of those fish moving from the upper tributaries and backwaters to the lower river on their seaward migration. Migration normally occurs during October and November. Juvenile bluebacks reached a mean length of 60 mm in December, 1975 and 51 mm in November, 1976 (Figure 11).

The abundance of juvenile blueback herring was much higher in 1976 than in 1975 (Table 1).

Alewife

Young alewife were distributed throughout the river system up to Lillington Creek in 1975 and above N C 53 in 1976 (Figure 12). The greatest concentration was found below Lane's Ferry with only an occasional individual being caught up the river during both years. Davis and Cheek (1967) reported capturing juvenile alewife up to Lane's Ferry.

Alewife were found in about equal numbers in the river and the tributaries during both years (Table 2). The major concentrations were found in the lower river and tributaries.

Alewife remained in the river until November of both years. The peak occurrence during 1975 was in September. During 1976 a high abundnace was observed during June, with a peak again in September (Figure 13). The June concentration was probably those fish moving downstream to nursery areas lower in the Cape Fear estuary. During November 1975, they reached a mean fork length of 59 mm compared to a length of 64 mm in November 1976 (Figure 14).

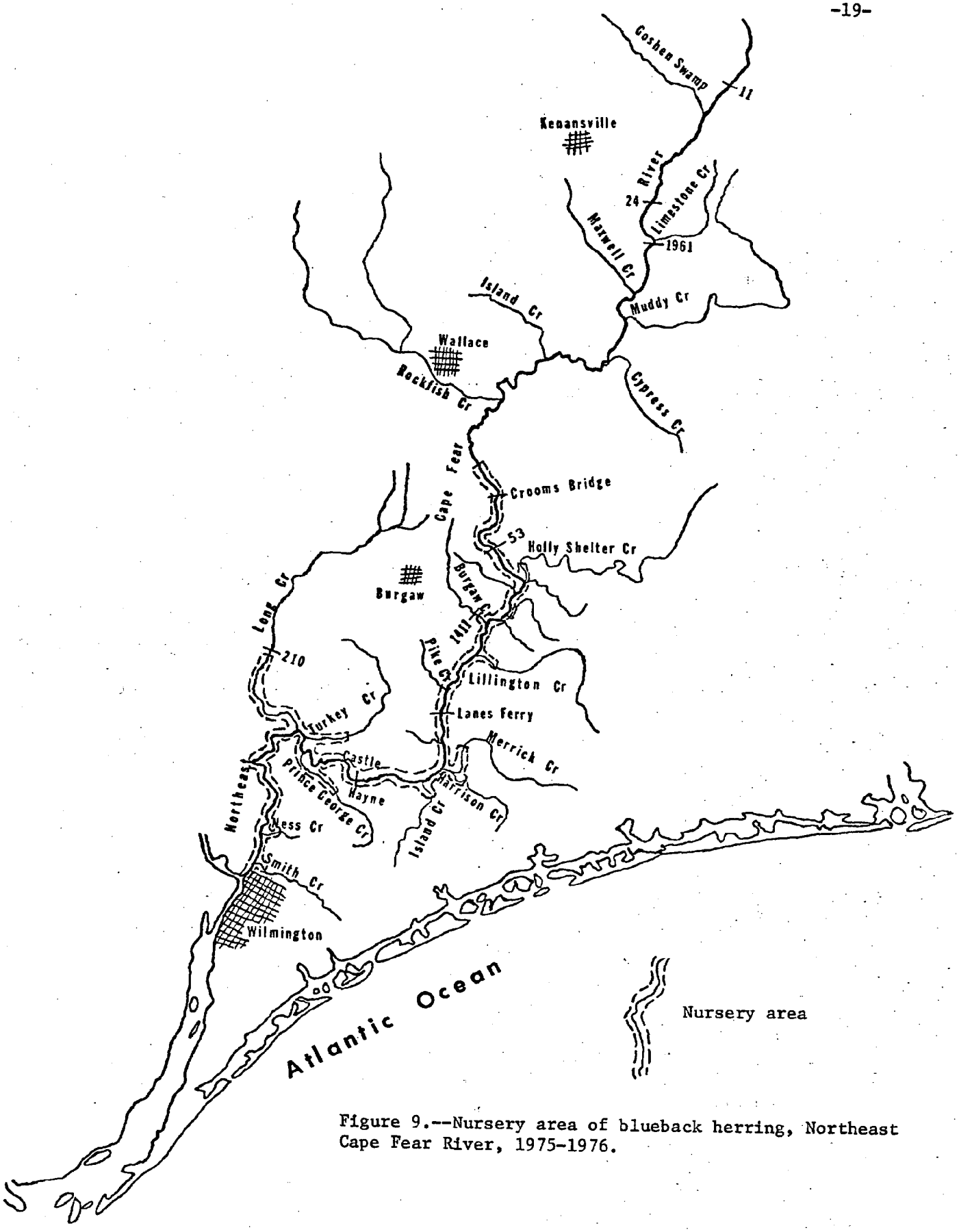
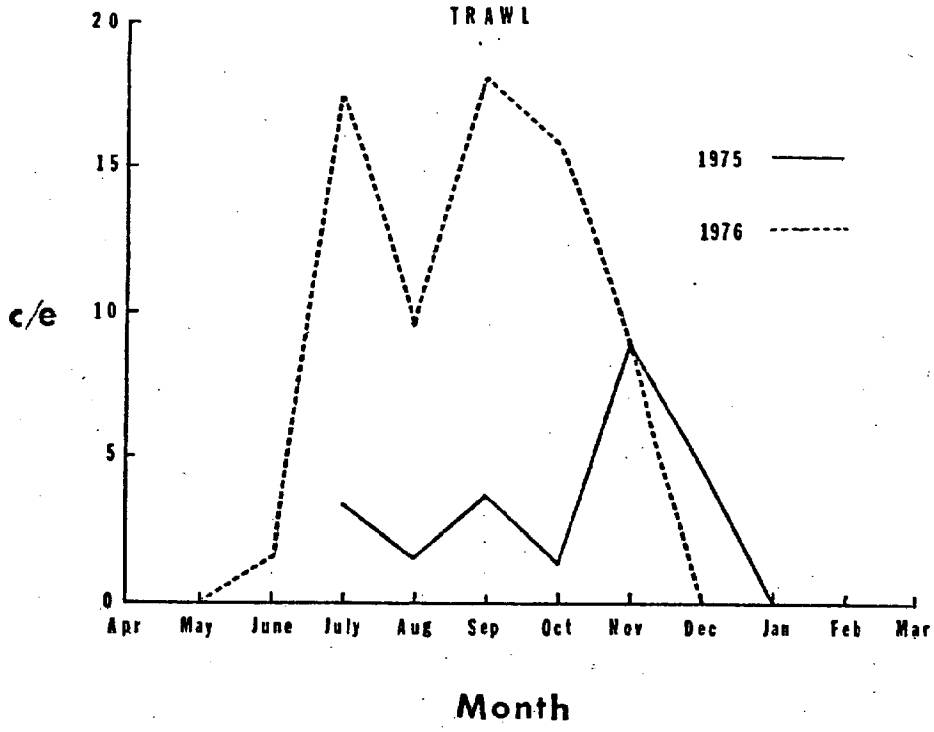


Figure 9.--Nursery area of blueback herring, Northeast Cape Fear River, 1975-1976.



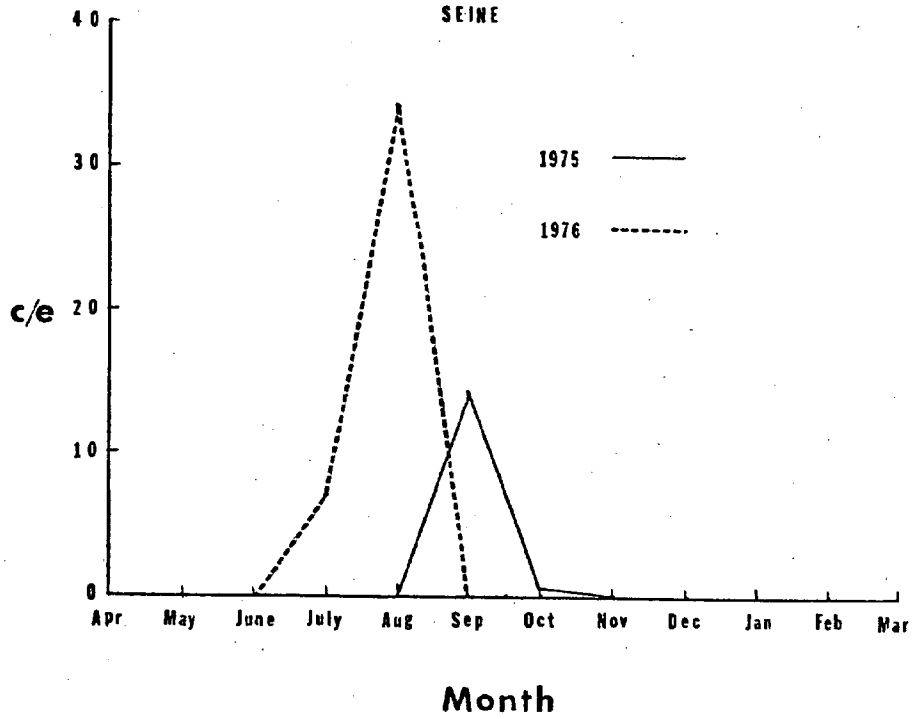


Figure 10.--Monthly catch per effort of juvenile blueback herring, Northeast Cape Fear River, 1975-1976.

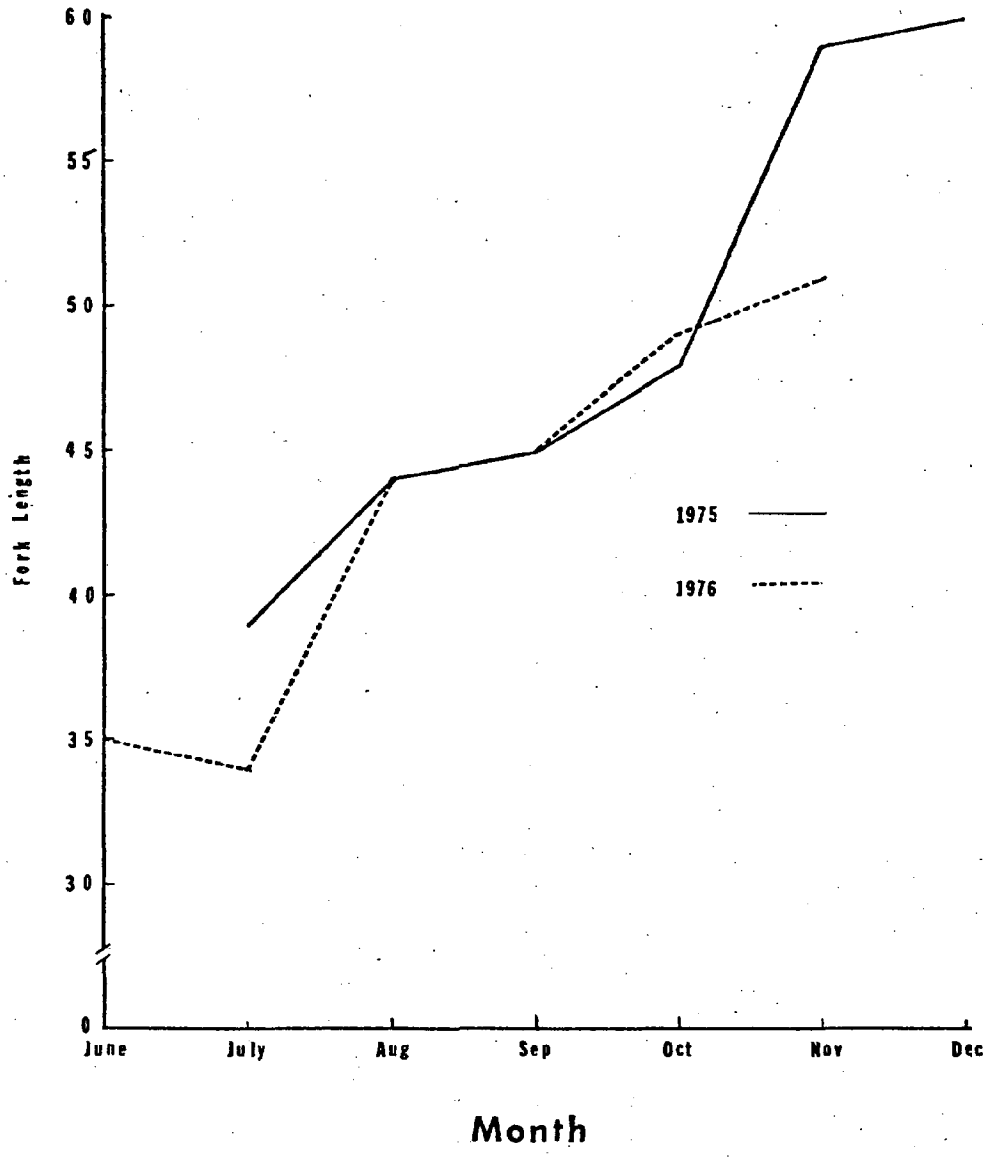


Figure 11.--Mean monthly fork length of juvenile blueback herring, Northeast Cape Fear River, 1975-1976.

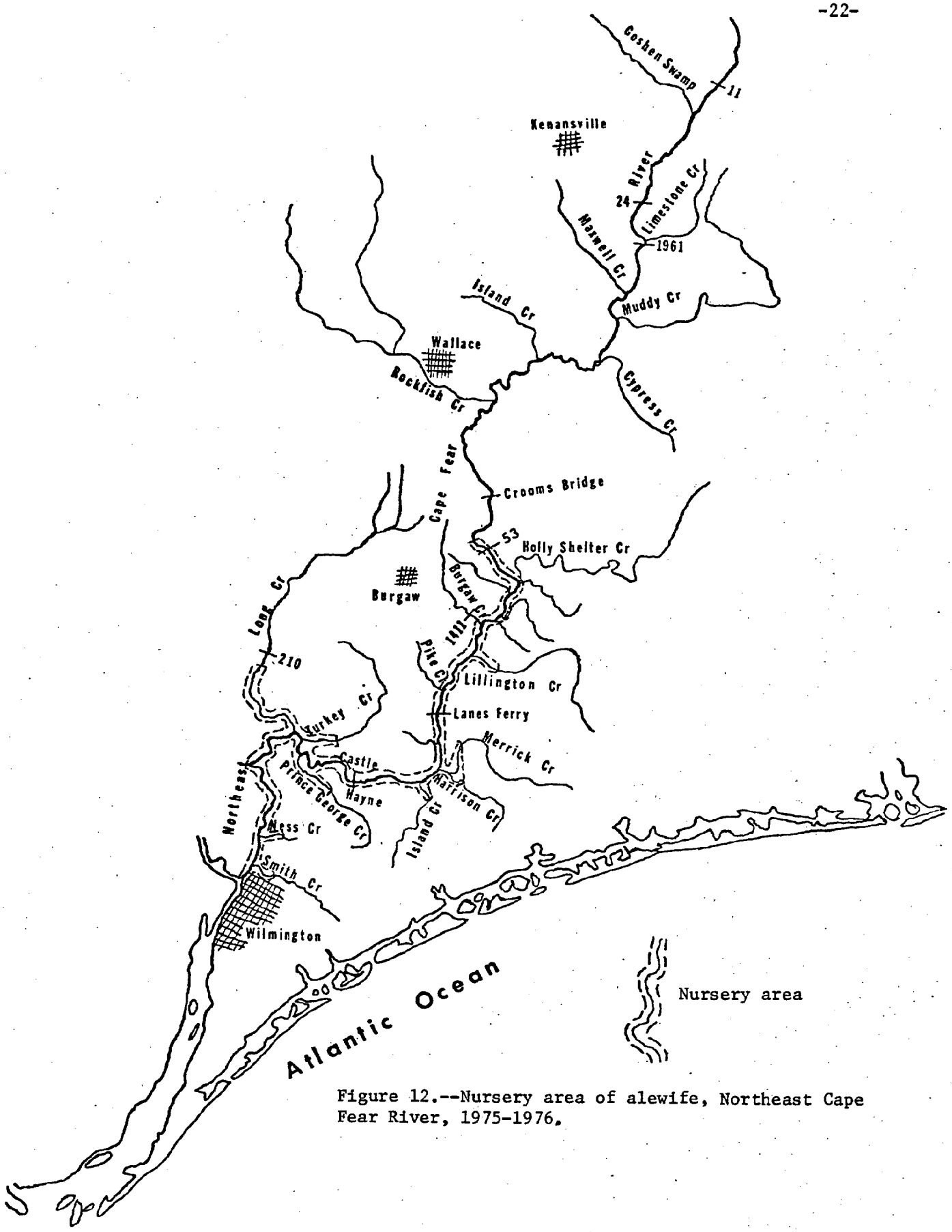


Figure 12.--Nursery area of alewife, Northeast Cape Fear River, 1975-1976.

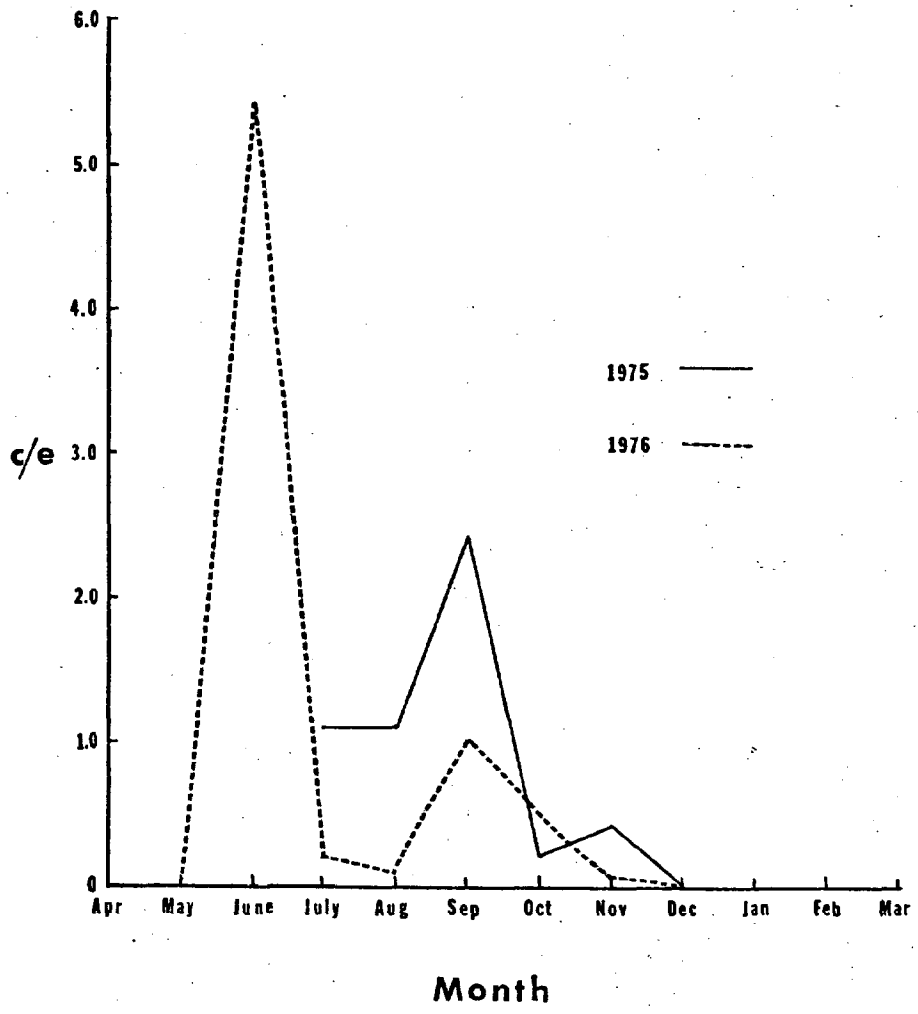


Figure 13.--Monthly catch per effort of juvenile alewife for wing trawl samples, Northeast Cape Fear River, 1975-1976.

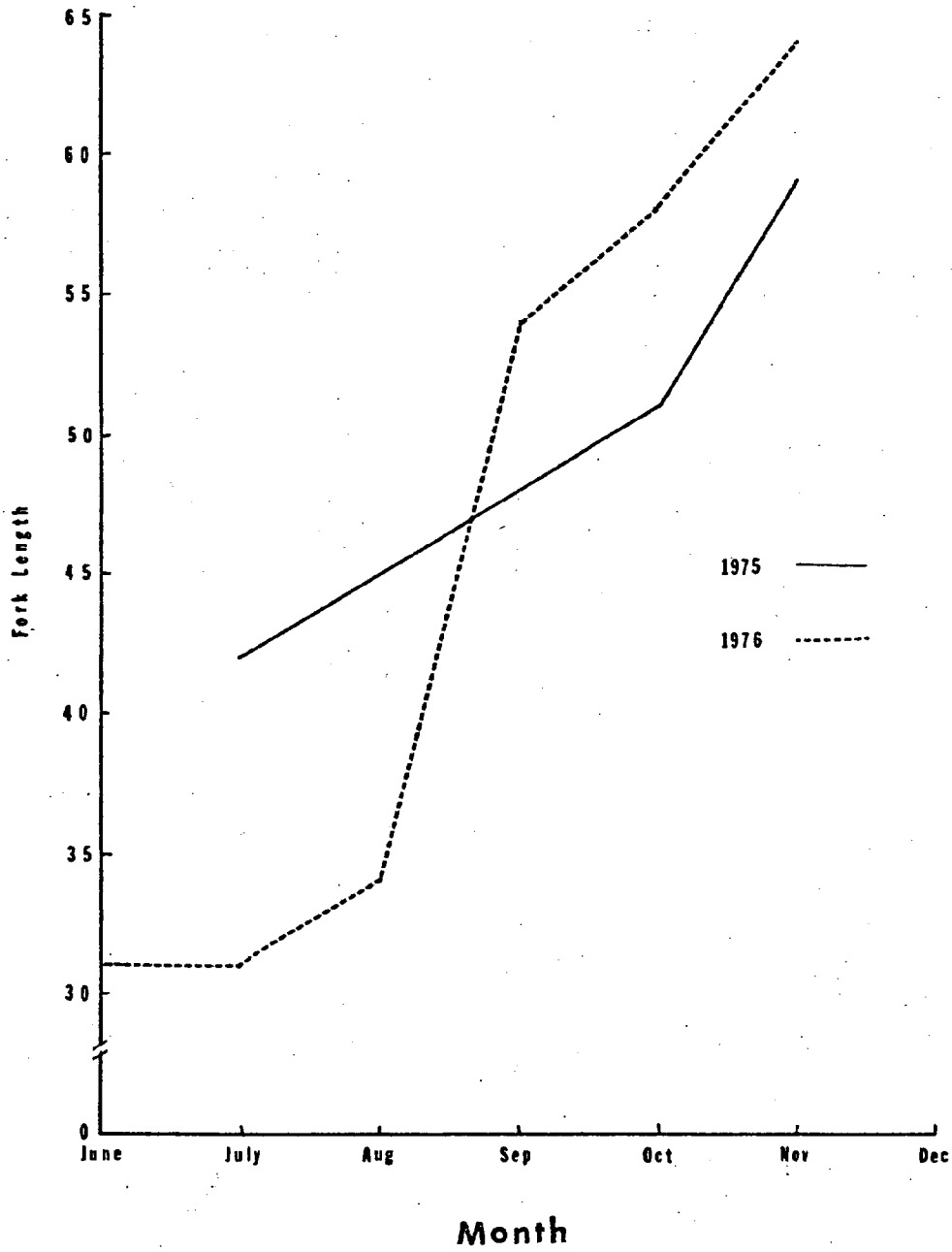


Figure 14.--Mean monthly fork length of juvenile alewife, Northeast Cape Fear River, 1975-1976.

Hickory shad

Juvenile hickory shad were found only during June 1976 and June 1977. Figure 15 shows their capture locations for both years. It is believed they were migrating out of the river to nursery areas just offshore as proposed by Godwin and Adams (1969). They had a mean fork length of 30 mm in June 1976 and 35 mm June 1977.

Striped bass

Young striped bass were found from Lane's Ferry to the river mouth (Figure 16). They were captured infrequently, and their highest C/e occurred during January 1976 (Figure 17). This was probably due to downstream migration and concentration in deeper water. None were found after June 1976. Monthly growth rates were not determined due to their infrequent capture and small sample size.

Atlantic sturgeon

A total of five immature Atlantic sturgeon were captured at river km 8 during the study period. They ranged from 340-774 mm and were probably moving downstream. This evidence indicates that a spawning population of sturgeon may exist in the Northeast Cape Fear River.

Adult Survey

From January through May 1976, a total of 63 American shad, 126 blueback herring, 56 alewife, 29 hickory shad, and 16 striped bass were caught in gill nets and haul seines. During March and April 1977, a total of 65 American shad, 294 blueback herring, 24 alewife, 36 hickory shad, and 10 striped bass were caught.

The adult runs did not begin until March 1977, probably due to the abnormally cold winter. However, water temperatures rose rapidly and by the end of April no adult activity was observed. During a "normal" winter and spring the runs begin in January and lasts into May.

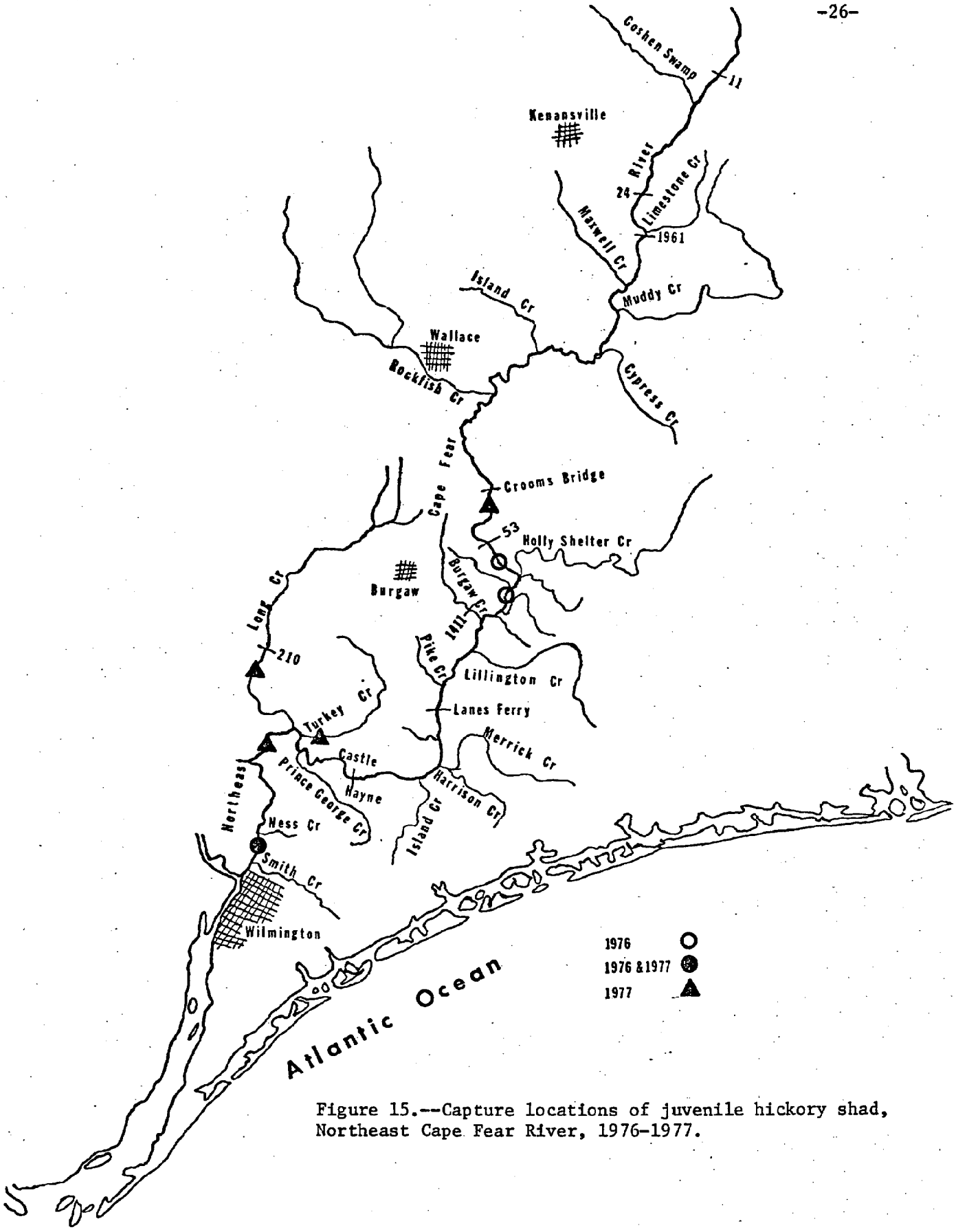


Figure 15.--Capture locations of juvenile hickory shad, Northeast Cape Fear River, 1976-1977.

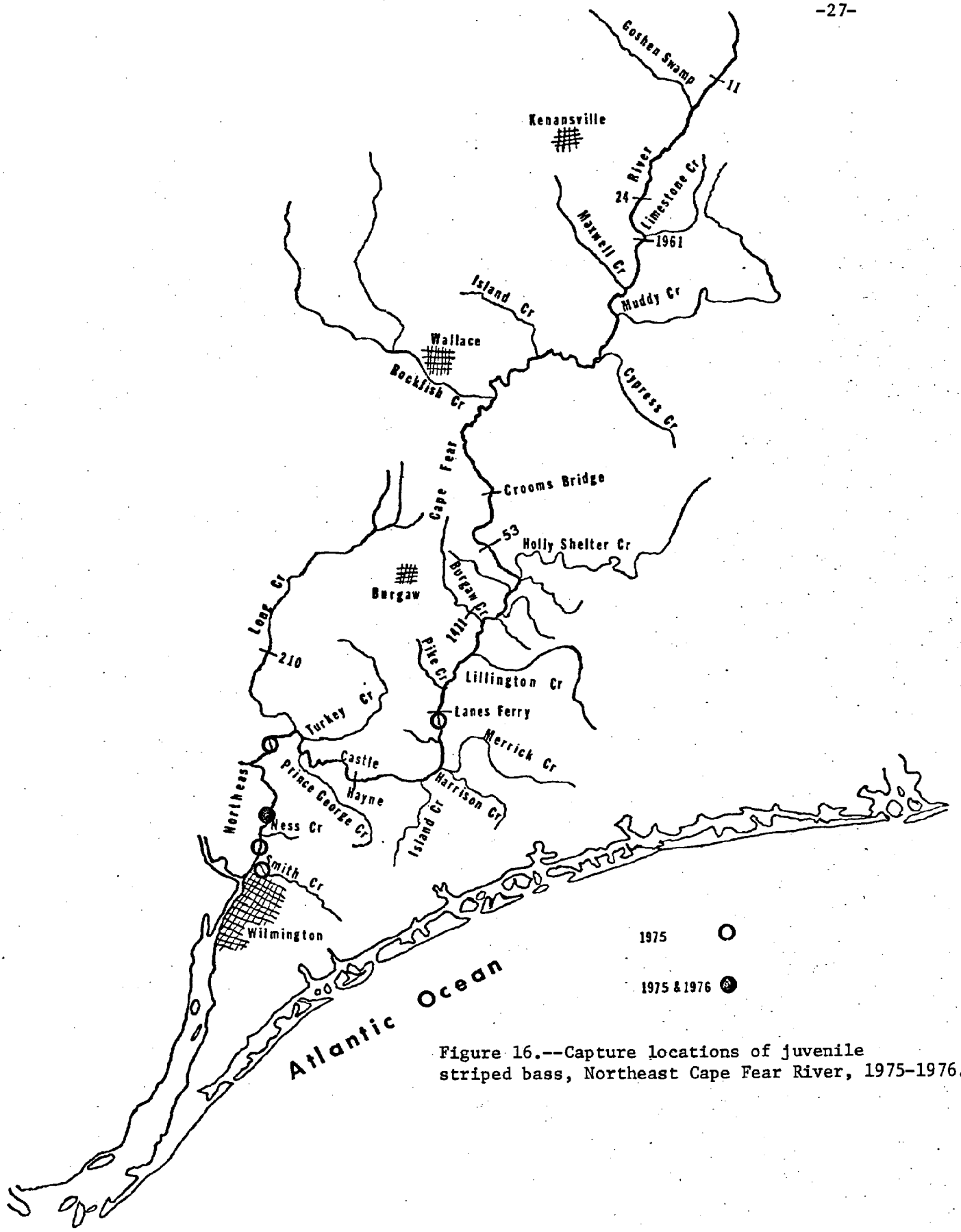


Figure 16.--Capture locations of juvenile striped bass, Northeast Cape Fear River, 1975-1976.

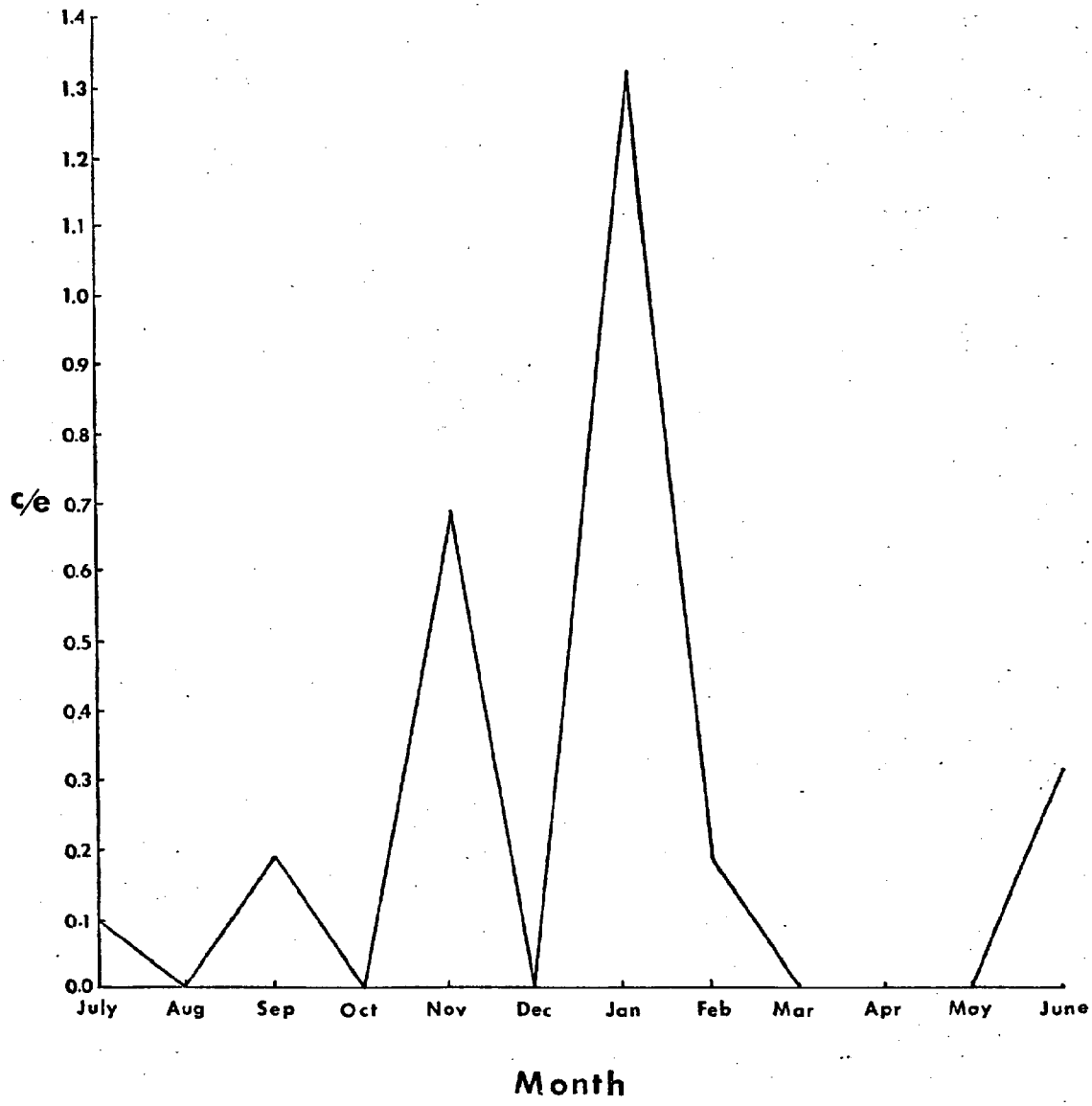


Figure 17.--Monthly catch per effort of juvenile striped bass, Northeast Cape Fear River, 1975-1976.

Abundance and Distribution - Gill Nets

American shad

Sampling adult American shad with anchored gill nets proved to be impractical due to the high current velocities. Only 18 adults were caught during the study period by this method. The haul seine proved to be the best method of capture, but it was fished at only one location.

Gill net sampling indicated a higher abundance of adult American shad during the 1977 run than during 1976 (Table 3). Adult American shad did not travel as far up the river in 1976 as in 1977 due to drought conditions. During 1976, gill net sampling resulted in the capture of one adult above Crooms' Bridge. None were found in the tributaries. They first entered the lower river during February and remained until May (Figure 18). They did not enter the river until March 1977 when the water temperature reached approximately $10^{o}C$ and remained through April. They were found up to Maxwell Creek. Figure 19 shows the distribution of adult American shad in the Northeast Cape Fear River during the springs of 1976-77.

Blueback herring

Adult blueback herring were significantly more abundant during 1977 than during 1976. They were found in the Northeast Cape Fear River during March and April of 1976-77 and May of 1976 with the greatest abundance during March and April (Figure 20). During 1976, they were found as far upstream as Crooms' Bridge and above NC 53 during 1977. The follwoing tributaries were found to contain runs of bluebacks: Smith Creek, Long Creek, Turkey Creek, Pike Creek, Lillington Creek and Burgaw Creek (Figure 21).

Alewife

Alewife was the only adult alosid showing a decrease in abundance during 1977 compared to 1976 (Table 3). They first entered the river during February 1976 and March 1977 and remained until April (Figure 22). Gill nets caught them as far upstream as Lillington Creek. They were found in the following tributaries: Long Creek, Turkey Creek, Prince George Creek, Pike Creek and Lillington Creek. Catches indicate that adult alewife ran earlier, but they were not distributed as far upstream as blueback herring.

TABLE 3.--Annual C/e of adult anadromous fish for gill net samples, Northeast Cape Fear River, 1976-1977.

	1976		1977	
	Catch	C/e	Catch	C/e
American shad	7	0.38	11	0.84
Hickory shad	3	0.21	6	0.46
Blueback herring	40	2.84	106	8.15
Alewife	53	3.76	16	1.23
Striped bass	10	0.31	6	0.23

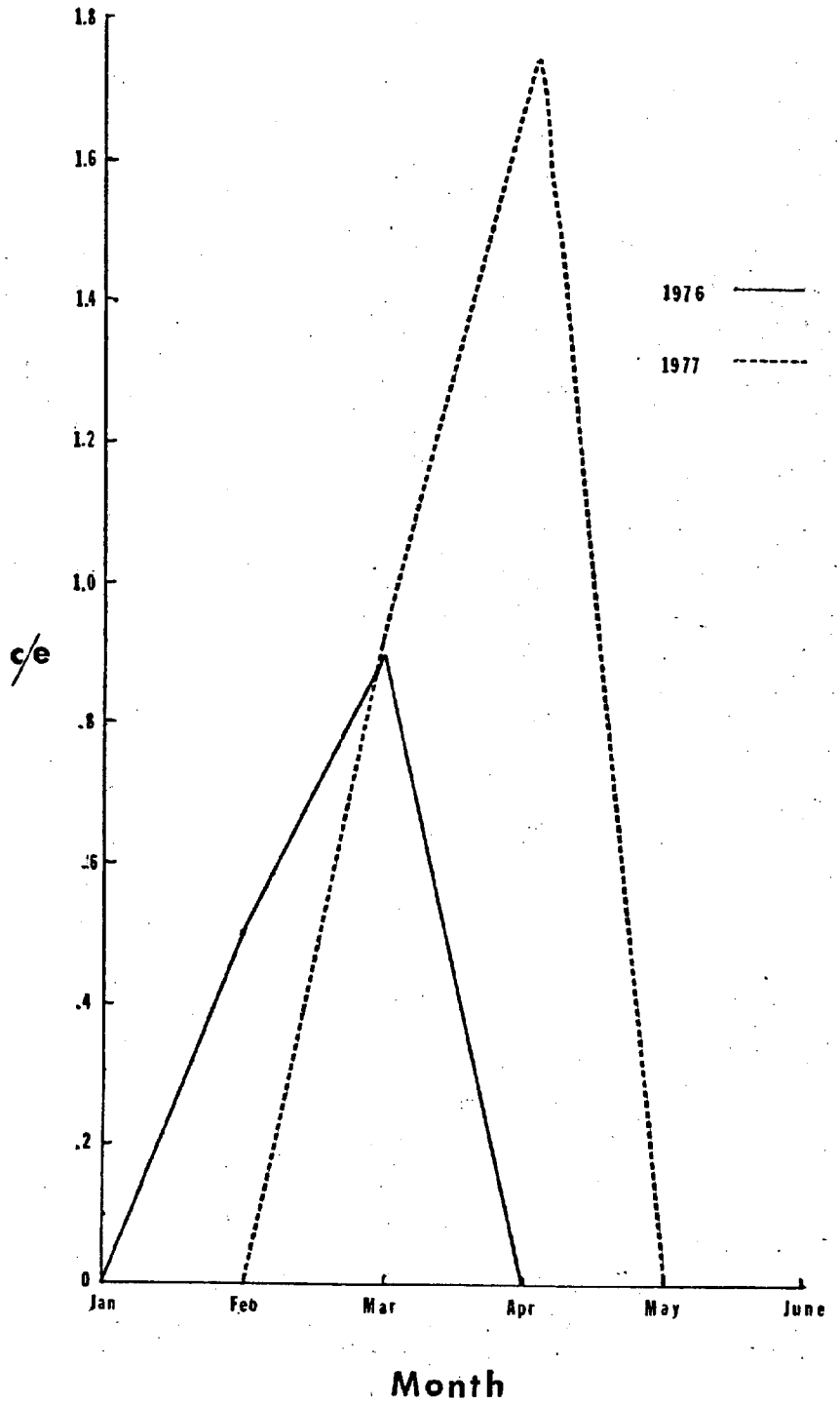


Figure 18.--Gill net catch per effort of adult American shad, by month, Northeast Cape Fear River, 1976-1977.

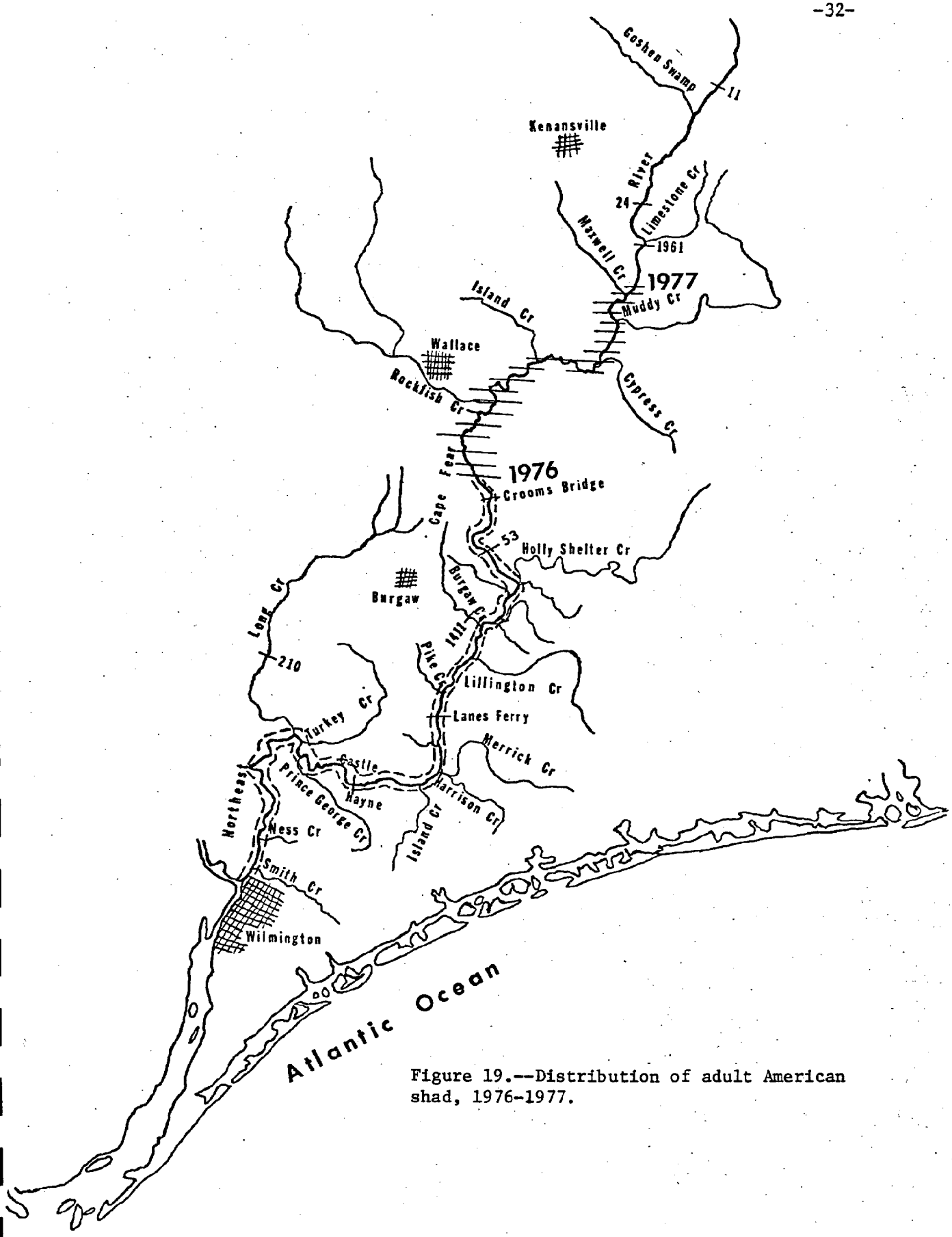


Figure 19.--Distribution of adult American shad, 1976-1977.

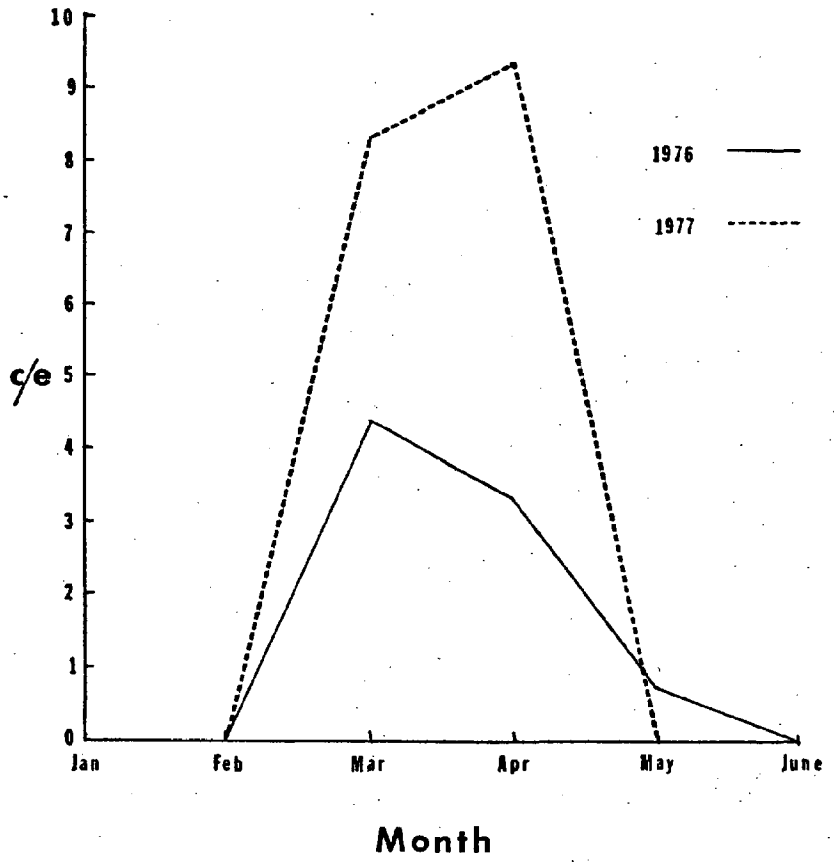


Figure 20.--Gill net catch per effort of adult blueback herring by month, Northeast Cape Fear River, 1976-1977.

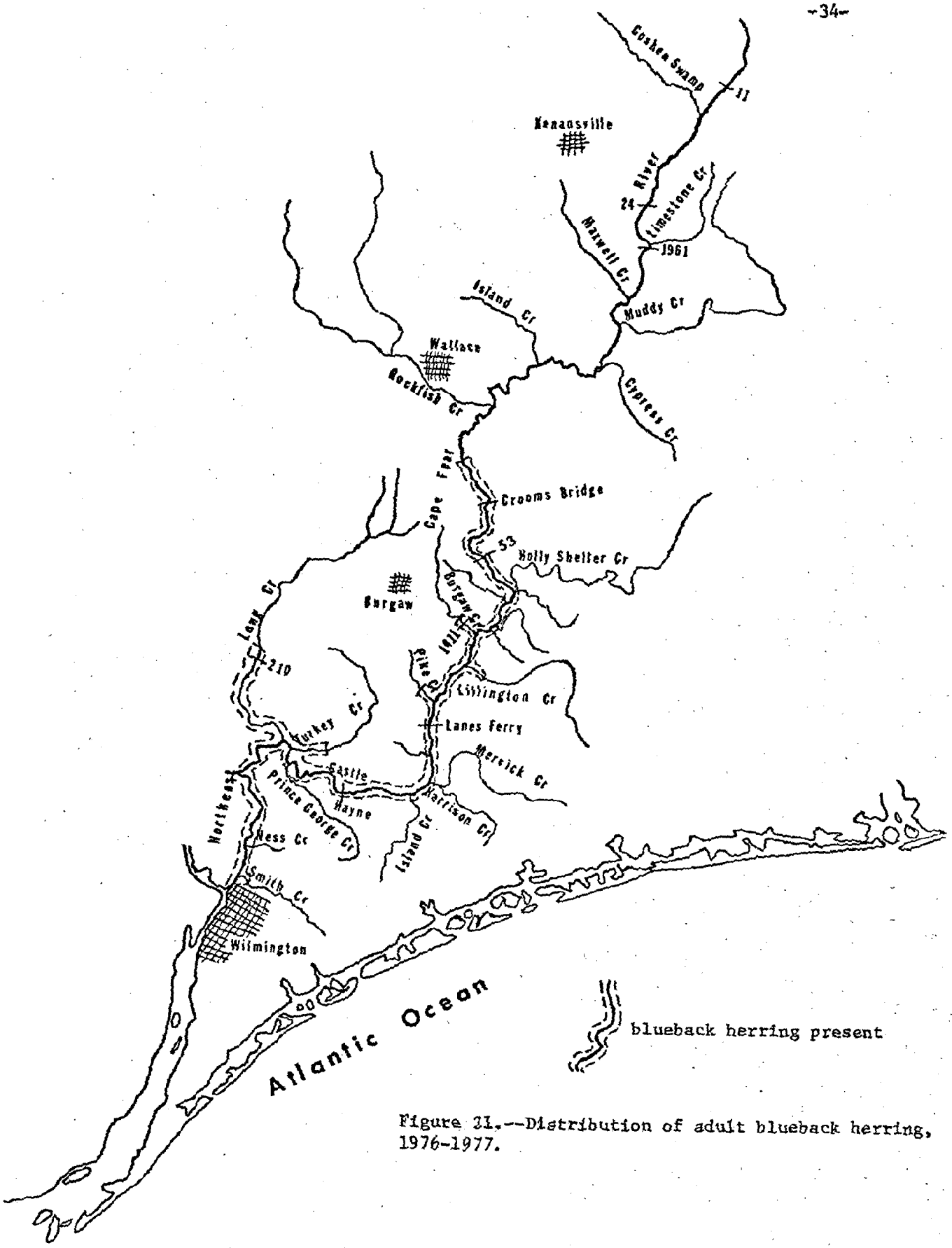


Figure 21.--Distribution of adult blueback herring, 1976-1977.

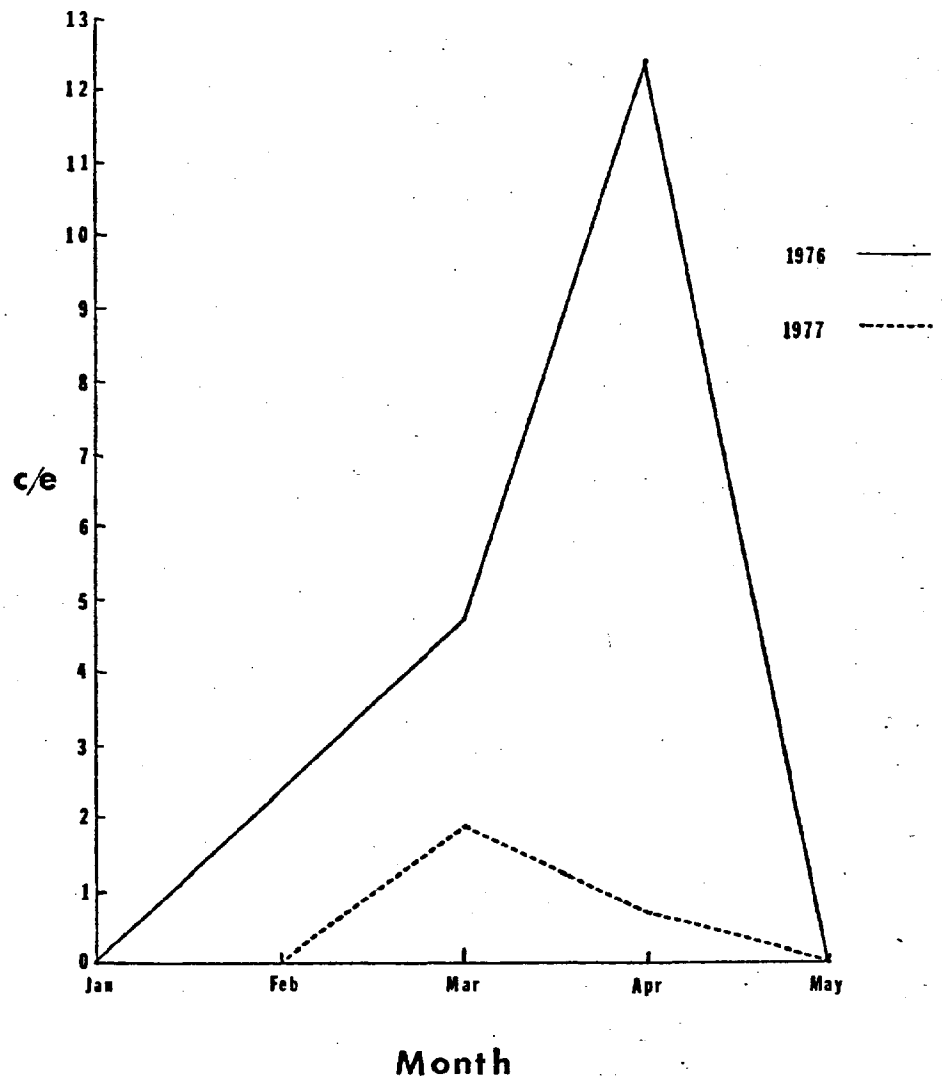


Figure 22.-- Gill net catch per effort of adult alewife by month, Northeast Cape Fear River, 1976-1977.

Hickory shad

Only nine adult hickory shad were caught in gill nets during the runs of 1976 and 1977. They were slightly more abundant in 1977 than in 1976. Hickory shad were found in the river up to Sanderson's seine and up to NC 210 in Long Creek, primarily during March of both years.

Striped bass

Striped bass were found throughout the spring with the greatest abundance occurring during April of both years (Figure 23). Gill net samples produced them as far upstream as Pike Creek; however, they range further as indicated by haul seine sampling. Four young individuals were found in Turkey Creek during May 1976. In addition, mature adults were found in Smith and Ness Creeks during March 1977.

Abundance - Haul Seine

American shad

Haul seine samples indicated American shad were slightly less abundant during 1977 than in 1976 (Table 4), although gill net samples indicated a higher abundance. However, gill net samples were taken predominatly downstream while the commercial fishery was taking place.

Adult shad were caught during March, April and May 1976 and during March and April 1977. Peak C/e occurred during April of both years (Figure 24).

Haul seine sampling produced unique data due to its location (Figure 27). The bulk of the shad fishing took place down river from the seine, As a result, the fish caught in the seine essentially represented escapement into the spawning areas. Although no reliable information exists on the unexploited population when it entered the river, the seine data were very useful. Abundance for both years was extremely low compared to what I personally remember catching ten years ago in the same seine. The male-female ratio was 4.7:1 in 1976 and 5:1 in 1977. This is probably due to the selectivity of the fishery downstream

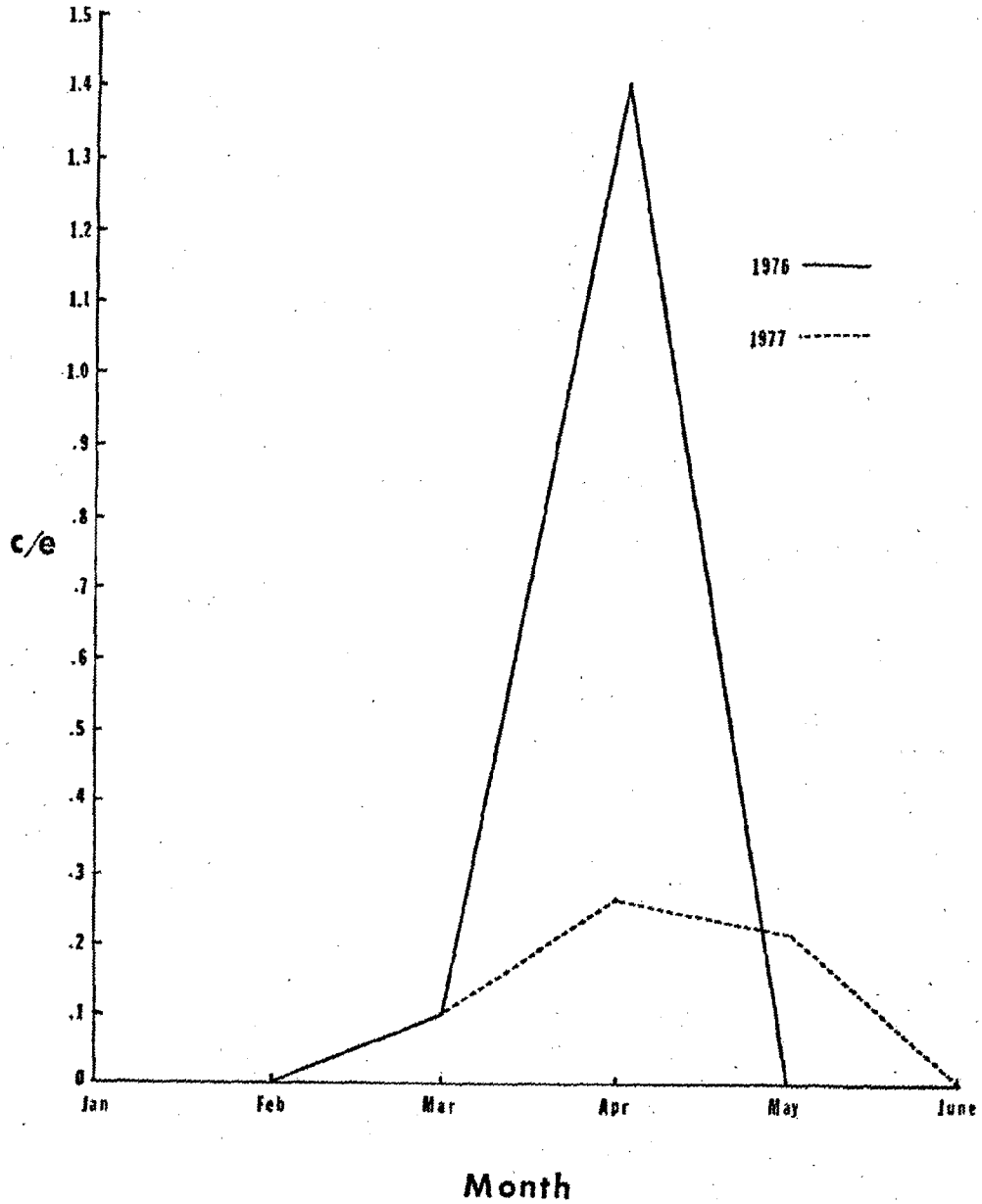


Figure 23.--Gill net catch per effort of adult striped bass by month, Northeast Cape Fear River, 1976-1977.

TABLE 4.--Total annual C/e of adult anadromous fish for haul seine samples, 1976-1977.

	1976			1977		
	Number hauls	Catch	C/e	Number hauls	Catch	C/e
	113			114		
American shad		56	0.50		54	0.47
Hickory shad		26	0.23		30	0.26
Blueback herring		85	0.75		188	1.65
Alewife		3	0.03		8	0.07
Striped bass		2	0.02		3	0.03

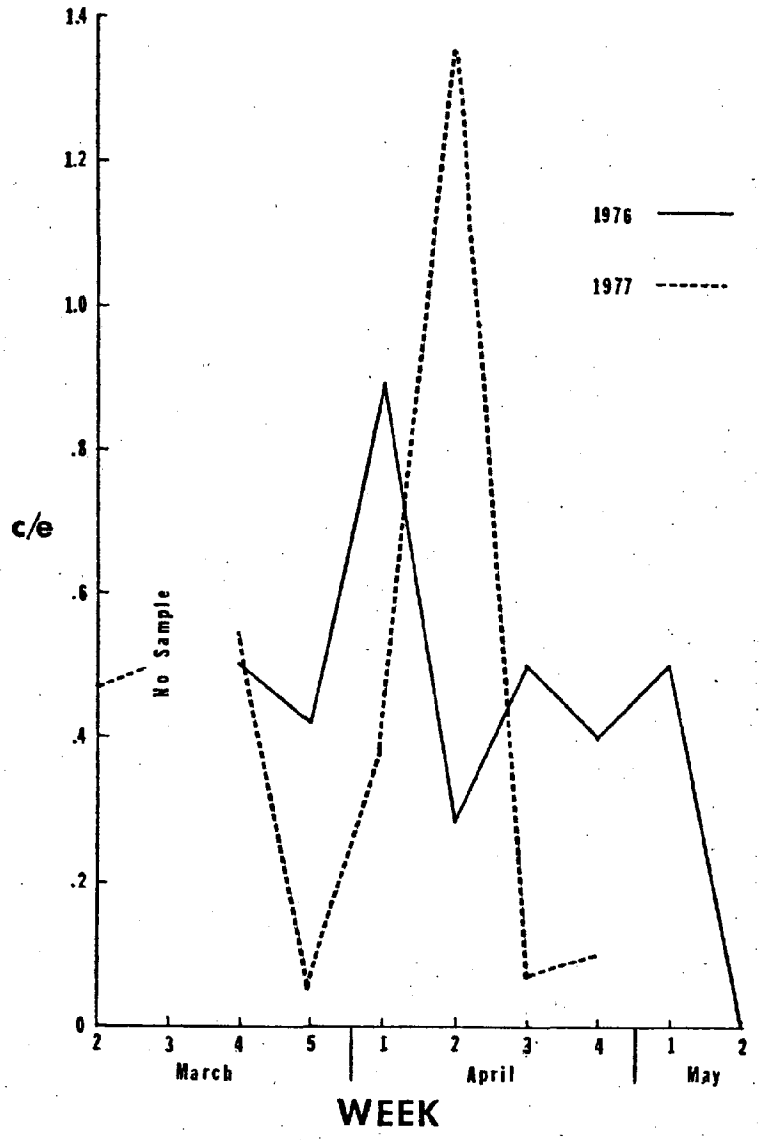


Figure 24.--Haul seine catch per effort of adult American shad, Northeast Cape Fear River, 1976-1977.

for "roes". In addition, some individuals examined had net scars, i. e., numerous scales removed and bloody spots on the back and sides behind the operculum. This information suggests that the American shad population is very low, possibly due in part to intensive fishing pressure in the lower river which prevents sufficient spawning escapement of females.

Blueback herring

Adult bluebacks were the most abundant species caught in the haul seine, with 273 fish taken during both years. They were substantially more abundant during 1977 than during 1976 (Table 4). This agrees with the results of the gill net survey. They were present and equally abundant during March and April (Figure 25).

Hickory shad, Alewife, Striped bass

Adult hickory shad were found to be only slightly more abundant in 1977 than in 1976 (Table 4). They were found to run earlier than other species with peak C/e occuring during the last week of March during both years (Figure 26). In addition, only a few alewife and striped bass were caught. The seine is believed to be located too far up river to catch many alewife. Striped bass were once caught frequently at this seine, but during the 1976-77 run very few were captured.

Age and Spawning Frequency

American shad

Because of the small number of shad caught by our gill nets, age, lengths, and spawning frequency data were combined with that from fish captured in the haul seine. As found in other state work, male American shad were predominately four years old and females were five. Males ranged from three to six years and females from four to seven (Table 5). The mean fork lengths generally agree with those found in other areas of North Carolina (Table 6). The male-female

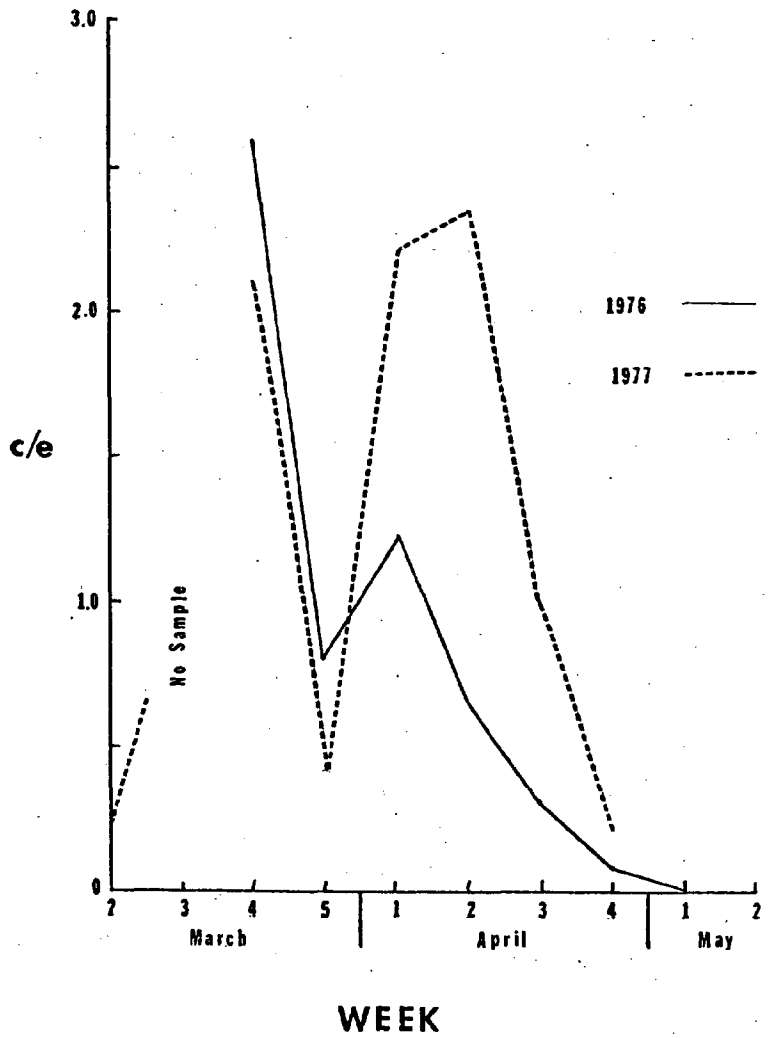


Figure 25.--Haul seine catch per effort of adult blueback herring, Northeast Cape Fear River, 1976-1977.

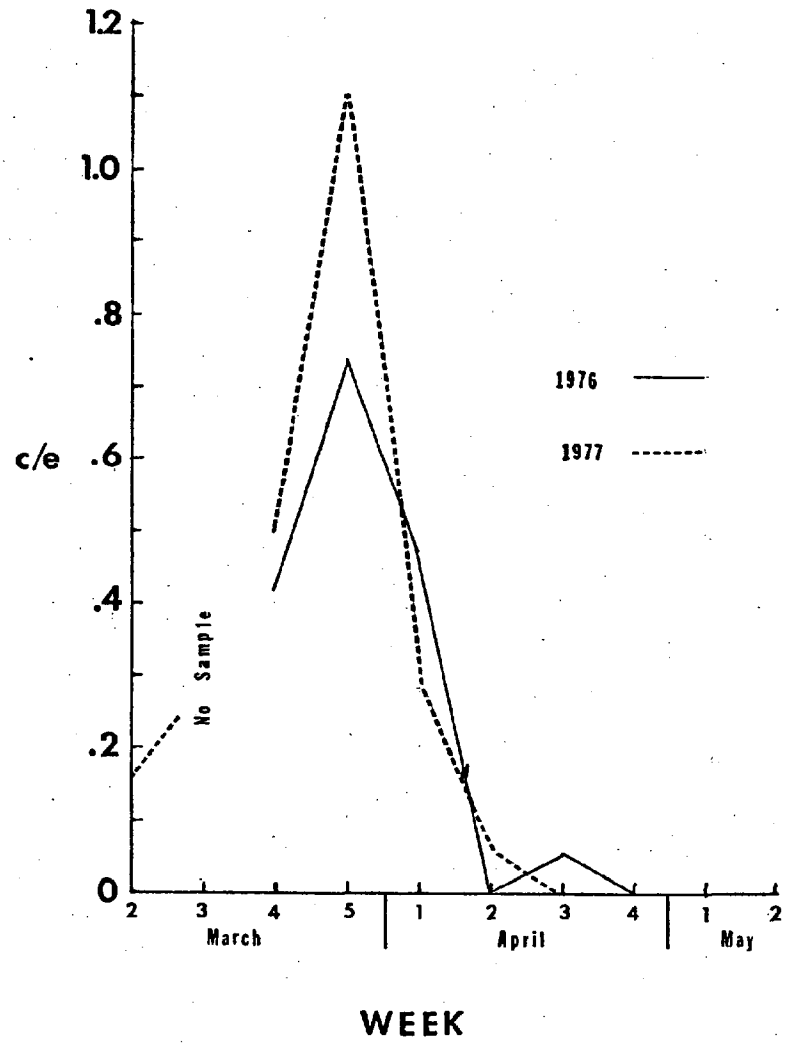


Figure 26.--Haul seine catch per effort of adult hickory shad, Northeast Cape Fear River, 1976-1977.

TABLE 5.--Total number, percent of total sample, mean fork length, and length range for each age group by sex for American shad, 1976-1977.

Sex	Age	Total number	Percent of total sample	Mean fork length (mm)	Length range (mm)
Male	III	4	4	370	363-375
	IV	77	76	390	341-427
	V	20	19	425	395-446
	VI	1	1	460	
		102			
Female	IV	2	8	436	430-442
	V	17	65	463	430-492
	VI	5	19	498	489-510
	VII	2	8	519	517-520
		26			

TABLE 6.--Age and mean fork length (mm) of American shad from Northeast Cape Fear compared to other areas of North Carolina.

Age	III		IV		V		VI		VII		VIII		IX	
Sex	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Location														
Northeast Cape Fear River	370		390	436	425	463	460	498		519				
Albemarle Sound[1]	359		400	437	432	473	450	498	461	540	476	509		571
Neuse River[2]	386	376	422	429		472		513						
Pamlico Sound[3] and River	334		415	445	437	481	456	494	470	489	485	522		549
Offshore North[4] Carolina			459		451		458		467		486		488	

[1]Street and Pate, 1975

[2]La Pointe, 1958; Calculated fork length in inches converted to mm

[3]Marshall, 1976

[4]Holland and Yelverton, 1973 (sexes combined)

sex ratio was 4.7:1 from haul seine samples in 1976. In 1977, the haul seine produced a sex ratio of 5.0:1 male-female; however, gill net samples downstream showed a sex ratio of 0.8:1 male-female. The haul seine which is located upstream from the fishery is believed to be representative of the spawning escapement. Although the gill net sample size was too small to draw any conclusions (N = 11), the haul seine data did indicate an unequal sex ratio of adult American shad existed after fishing occurred.

American shad in the Northeast Cape Fear River spawn only once. Out of a total of 365 scale samples aged, only five were found to have a spawning mark. This conclusion was confirmed by independent readings and thus far is believed to be the southernmost indication of American shad spawning repetition. Three males ages four and five, and two females ages five and eight were found to be repeaters.

Blueback herring

Blueback herring ranged in age from three to seven years. Males were predominantly four and five, and females were five (Table 7). The mean fork lengths for each age group agree closely with those found in other investigations in North Carolina (Table 8). There was a high proportion of females compared to males, resulting in a sex ratio of 2.3:1 from the 1976 haul seine samples. Gill nets sampled in 1976 also produced a higher number of females with a 1.2:1 female-male ratio. However, in 1977 haul seine samples resulted in a 1.6:1 female-male ratio while gill nets showed a 1.7:1 male-female ratio. The combined sex ratio was 1.1:1 female-male. The relatively large mesh (6.4cm) of the seine was felt to be selective for females because some small bluebacks believed to be males were observed going through the net primarily during the latter part of the run.

Repeat spawning was considerably less than that found in the Albemarle Sound (50 percent - Street and Pate, 1975) and Tar River (70 percent - Pate, 1975) areas of North Carolina. Only 16 percent of the Northeast Cape Fear River blueback herring sampled showed evidence of prior spawning. Virgin fish accounted for 82 percent of the females and 88 percent of the males samples. None were found to have more than two spawning marks (Table 9).

TABLE 7.--Total number, percent of total sample, mean fork length, and length range for each age group by sex for blueback herring, 1976-1977.

Sex	Age	Total number	Percent of total sample	Mean fork length (mm)	Length range(mm)
Male	III	10	6	231	213-239
	IV	92	54	242	221-258
	V	66	39	253	225-268
	VI	3	2	264	263-364
		171			
Female	III	2	<1	239	238-240
	IV	38	17	247	233-260
	V	169	71	262	246-277
	VI	21	9	275	262-293
	VII	1	<1	275	
		231			

TABLE 8.--Age and mean fork length (mm) of blueback herring from Northeast Cape Fear compared to other areas of North Carolina, 1976-1977.

Age	III		IV		V		VI		VII		VIII		IX	
Sex	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Location														
Northeast Cape Fear River	231	239	242	247	253	262	264	275		275				
Albemarle Sound[1]	229	244	237	248	247	257	251	264	259	270	270	280		307
Offshore North Carolina[2]	208		219		235		255		270		280			
Tar River[3]			238	244	250	255	258	266	264	275		279		291
White Oak River[4]	219		237	242	247	258	249	265		280				

[1]Street and Pate, 1975

[2]Holland and Velverton, 1973 (sexes combined)

[3]Marshall, 1976

[4]Sholar, 1975

TABLE 9.--Age and spawning frequency of blueback herring, 1976-1977 combined.

Number of spawning marks	0		1		2		Total	
Age	M	F	M	F	M	F	M	F
III	10	2					10	2
IV	86	50	6				92	50
V	54	132	10	28	1		65	160
VI	1	6	3	9	1	5	5	20
VII				1				1
Total	151	190	19	38	2	5	172	233
Percent	(88)	(82)	(11)	(16)	(1)	(2)		

Alewife

Adult alewife ranged in age from three to six years. Males were predominantly four years old and females were four and five (Table 10). The male:female sex ratio was 2.2:1 in 1976. However, in 1977 the sex ratio was 0.9:1 male-female. Females were observed to repeat more than males. Eighty-four percent of the females and 96 percent of the males were virgin (Table 11). This is a low frequency of repeat spawning compared to those from the Albemarle Sound area of North Carolina (Street and Pate, 1975). None were found with more than two spawning marks.

Hickory shad

Hickory shad ranged from three to six years in age. Males were predominately four and females four and five (Table 12). The sex ratio was 1.5 males to 1 female in 1976 and 0.5:1 male-female in 1977. Males were found to repeat slightly more than females. Twenty-seven percent of the males examined showed evidence of prior spawning while 23 percent of the females were repeaters (Table 13). Some males had two spawning marks while no female was found with more than one spawning mark.

Striped bass

Striped bass ranged from two to nine years of age. Of 29 captured, there were 20 males and 9 females (Table 14).

Commercial and Recreational Harvest

American shad

The primary method of harvest of American shad in the Northeast Cape Fear River is drift gill nets from 45.7 m to 91.4 m in length, with 14 cm stretched mesh. Drift net fishing occurs primarily below Lane's Ferry. Above Lane's Ferry

TABLE 10.--Total number, percent of total sample, mean fork length, and fork length range for each age group by sex for alewife, 1976-1977.

Sex	Age	Total number	Percent of total sample	Mean fork length (mm)	Length range (mm)
Male	III	1	2	226	
	IV	41	85	239	225-253
	V	5	11	250	244-261
	VI	1	2	270	
		48			
Female	IV	15	47	247	238-259
	V	16	50	263	250-272
	VI	1	3	275	
		32			

TABLE 11.--Age and spawning frequency of alewife, 1976-1977 combined.

Number of spawning marks	0		1		2		Total	
Age	M	F	M	F	M	F	M	F
III	1						1	
IV	39	15					39	15
V	2	11	2	4			4	15
VI	2					1	2	1
Total	44	26	2	4		1	46	31
Percent	(96)	(84)	(4)	(13)		(3)		

TABLE 12.-- Total number, percent of total sample, mean fork length and length range for each age group by sex for hickory shad, 1976-1977.

Sex	Age	Total	Percent of total sample	Mean fork length (mm)	Length range (mm)
Male	III	6	20	285	264-302
	IV	17	57	308	282-324
	V	6	20	352	311-409
	VI	1	3	433	
		30			
Female	IV	19	54	343	304-390
	V	16	46	357	325-396
		35			

TABLE 13.--Age and spawning frequency of hickory shad, 1976-1977.

Number of spawning marks	0		1		2		Total	
Age	M	F	M	F	M	F	M	F
III	8						8	
IV	10	16	4	2			14	18
V	3	11	1	6	2		6	17
VI					1		1	
Total	21	27	5	8	3		29	35
Percent	(72)	(77)	(17)	(23)	(10)			

TABLE 14.--Total number, percent of total sample, mean fork length and length range for striped bass, 1976-1977, sexes combined.

Age	Total number	Percent of total samples	Mean fork length (mm)	Length range (mm)
II	7	24	271	240-282
III	4	14	328	281-354
IV	3	10	428	340-490
V	7	24	542	471-589
VI	2	7	557	550-564
VII	4	14	777	699-805
VIII	0			
IX	2	7	830	830
	29			

fishing is done with short, anchored gill nets. These range from 9.2 m to 27.4 m and are set primarily at bends in eddies due to the swift current. These nets are set perpendicular to the current. Placing them in series from opposite banks, they may actually block the river at times. Also, there are five haul seines operating in the Northeast Cape Fear River. They are located from Holly Shelter Creek to Muddy Creek (Figure 27). They are jointly owned by families or communities, and are fished for personal consumption. Only one net is rented out by the day. Even this activity is not commercial, but mostly for groups to catch fish for cookouts and personal consumption. Historically, there were many seines in the river. Cobb (1906:16) reported that "In 1896 there were operated on this river...17 seines....A number of seine-beaches have not been worked for some years now, owing to the scarcity of fish." Seines are currently operated by hand by the use of ropes across the river. This very effective method of fishing is currently operated in much the same way as it was during the colonial period when seining first began.

The bulk of the shad landed during the 1976-77 run came from drift gill nets below Lane's Ferry. These were recreational fishermen who sold the fish they caught in excess of what they wanted for personal consumption. There were only a few commercial shad fishermen. They were primarily men who have fished many years in the same areas. Fishing began during February and lasted well into May in 1976. In 1977, fishing did not begin until March due to the unusually cold winter and lasted through April. During the peak of the 1976 run, as many as 25 shad were caught per drift gill net fisherman per day. However, in 1977 fishermen reported catching as many as 60 fish per day. An average day produced approximately 20 fish per boat. Personal observation of fishing revealed that approximately twice as much effort was being put into the shad fishery during March and April 1977 than during 1976. This was probably due to a greater abundance of fish. There appeared to be a greater number of fishermen in 1977 and each was making more trips per season.

The high fishing success may not have been due to a higher abundance of fish, but to the shortened season. The number of fish that would normally run were confined to a shorter time period due to cold water temperature, increasing the density of fish and making fishing more successful.

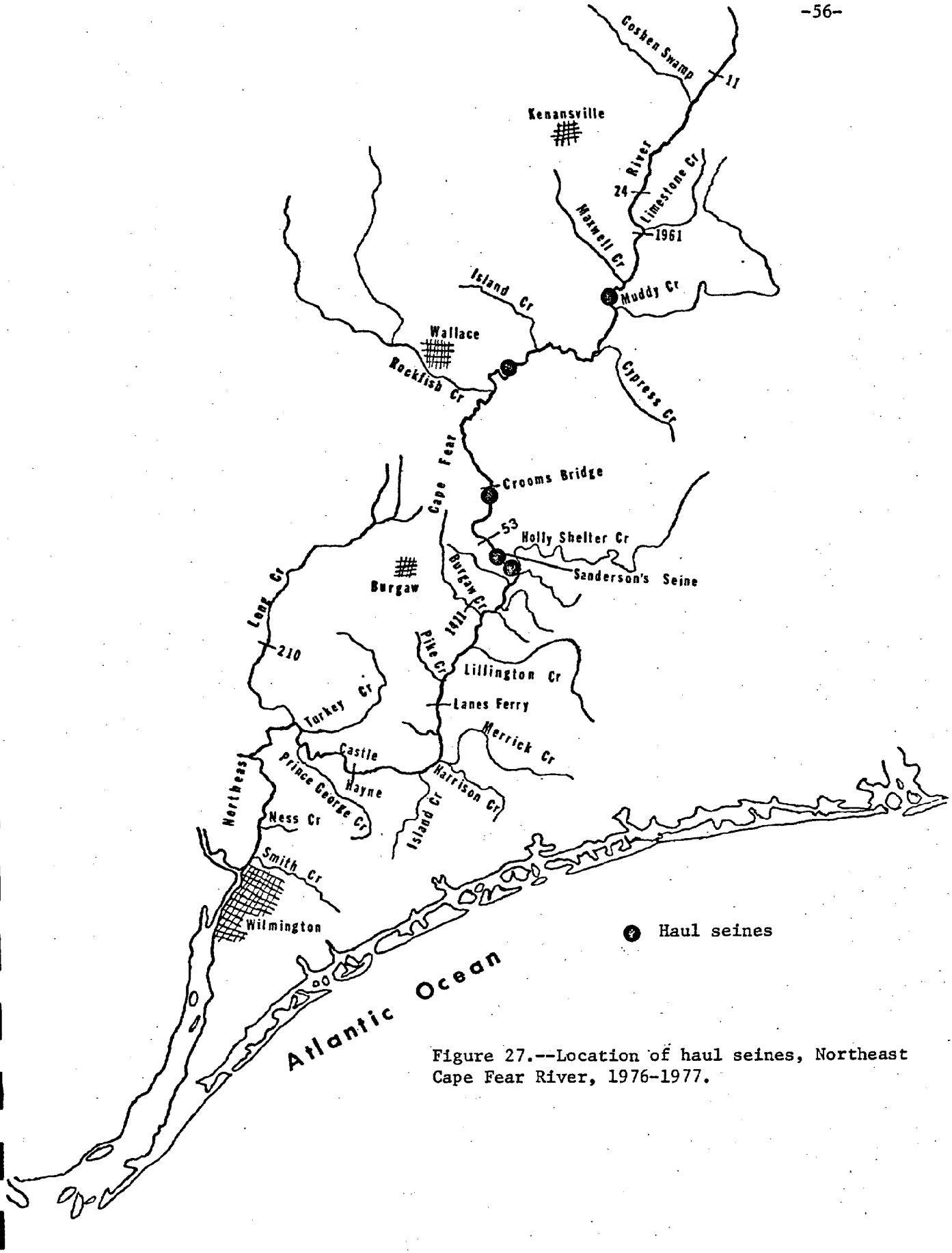


Figure 27.--Location of haul seines, Northeast Cape Fear River, 1976-1977.

The anchored gill net fishermen caught fewer fish than the drift netters. Personal communication with fishermen revealed that a 9.2 m net averaged only 20-30 fish during the entire season in 1976 and 100-150 per season during 1977. There were approximately 228.5 m (250 yards) of anchored shad nets set during both years. They were set during February and March and left until mid-May in 1976. Fishing was limited primarily to March and April in 1977. Most were not lifted the entire season. They were fished and cleaned out at least once a day, and most were fished twice a day.

The haul seines were operated from March to May. The three seines below Crooms' Bridge produced a reasonable amount of fish while the other two were rarely fished during the season. Sanderson's seine, which is rented out, produced the greatest catch because it was operated most frequently. During one day in April 1976, a total of 96 shad were caught between 6 AM and 6 PM, the best day reported during both the 1976 and 1977 seasons.

During the 1977 season, groups renting Sanderson's haul seine were given logs and asked to keep records of their catches and the number of hauls made. Catches were recorded by species and sex for American shad and hickory shad. Since the Division was sampling with the same haul seine one day per week, comparisions of the Division's C/e were made with those reported by fishermen. T-tests revealed no significant differences in C/e between Division samples and fishermen reports except for female American shad (Table 15). This difference was significant at the 95 percent confidence limit but was not significant at the 99 percent limit. The fishermen's records appear to be valid and should be continued. The data could be useful in the future as an indicator of abundance and spawning escapement throughout the season.

Sampling commercial catches was limited primarily to the drift net fishermen due to difficulties in locating other fishermen with catches. However, the length, sex, and age data should be generally the same as that obtained from the drift net fishermen since they were using the same mesh size (14.0 cm). A total of 237 scale samples were suitable for aging. Ages ranged from four to eight years. Males were predominantly age four and females five (Table 16). Figure 28 compares the length frequencies of shad from the drift nets with those samples by our gill nets and haul seine. The bulk of the gill net harvested

TABLE 15.--T-test comparison of the Division's weekly C/e and fishermsn's reported weekly C/e of adult anadromous fishes, Sanderson's haul seine, 1977.

	Total Division C/e	Total Fishermen C/e	D. F.	T Value	Significant difference at 95% confidence
American shad male	0.36	0.53	13	1.35	no
American shad female	0.07	0.31	13	2.32	yes
Hickory shad male	0.08	0.03	13	1.73	no
Hickory shad female	0.18	0.10	13	0.96	no
River Herring	1.58	1.52	13	0.80	no

TABLE 16.--Total number, percent of total sample, mean fork length and length range for each age group by sex for commercially-harvested American shad, 1976-1977.

Sex	Age	Total number	Percent of total sample	Mean fork length (mm)	Length range (mm)
Male	III	1	1	360	
	IV	45	48	396	370-434
	V	42	45	434	400-475
	VI	4	4	470	460-480
	VII	2	2	494	477-510
		94			
Female	IV	14	10	432	402-450
	V	103	72	460	420-500
	VI	23	16	489	457-520
	VII	2	1	513	510-515
	VIII	1	<1	557	
		143			

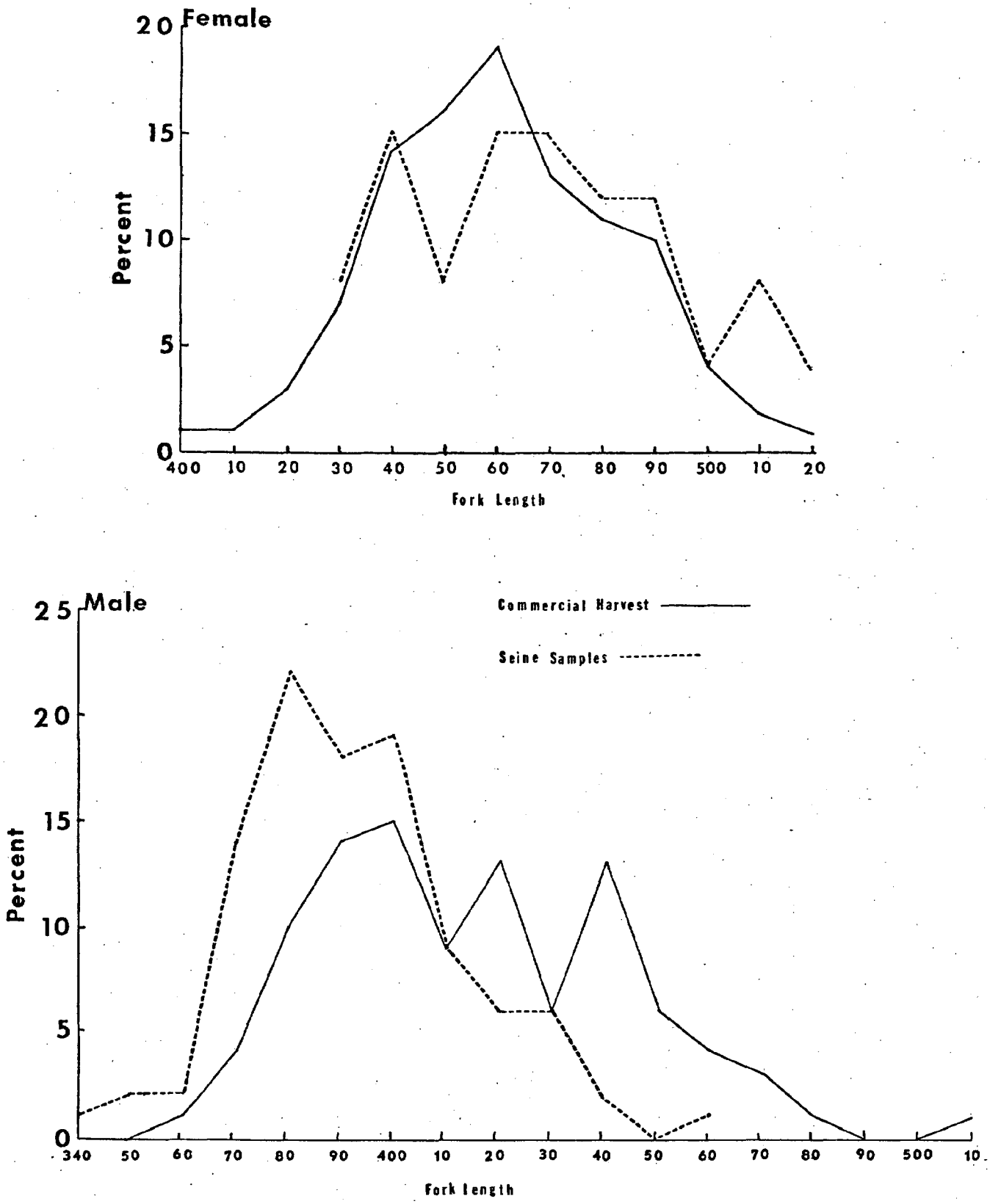


Figure 28.--Length frequency of commercially-harvested and haul seine-sampled American shad, Northeast Cape Fear River, 1976-1977.

females ranged between 440 mm and 490 mm. Smaller male shad were taken in the seine samples than by the drift net fishermen. T-tests comparing the fork lenghts of unculled commercially-harvested shad and seine-and gill net-sampled shad revealed a significant difference for both females (t = 2.86 at 84 d.f.) and males (t = 32.46 at 133 d.f.) at 95 percent confidence. This indicates the fishery is selective for age five females.

The sex ratio of American shad was computed from samples taken from fishermen before they reached the fish house or before any fish were sold or culled. The unculled ratio was 1.1:1, males to females during 1976 compared to a seine sex ratio of 4.7:1, male-female. During the 1977 run, unculled fishermen samples produced a sex ratio of 0.46 male-female compared to a 5:1 male-female ratio observed from haul seines and gill net samples. This also indicates the fishery is selective for the more valuable females.

River herring

Only a limited amount of herring fishing is done in the Northeast Cape Fear River. Some herring are caught in gill nets set in swamps and sloughs off the river, and some fishermen were observed drifting herring nets in the river during the 1977 run. They are not caught to sell but for personal consumption or to bait catfish traps and trot lines. Very few samples of river herring were obtained from fishermen. As a result, no conclusions can be made concerning age composition or length frequencies.

The bulk of the herring harvested in the Northeast Cape Fear River was by haul seines. Communication with fishermen indicated truck loads of herring were once caught in the seines. Now they may produce 23 - 34 kg (50 - 75 lbs) of herring per day during the peak of the run.

Hickory shad

Hickory shad are not harvested in any great numbers in the Northeast Cape Fear River. A few are caught in herring nets, but most are harvested by haul seines. Most fishermen believe hickory shad are river herring and are treated as such. This is probably one of the reasons why there are little or no reported landings of hickory shad from the Cape Fear River system.

Striped bass

Striped bass are caught infrequently by shad fishermen. However, they are not allowed to keep stripers caught in nets in New Hanover County by regulation. A few are landed in other counties. Some are harvested in haul seines, but not in significant numbers. A limited amount of hook-and-line fishing for striped bass is pursued with moderate success.

Large striped bass are reportedly taken each year in the Northeast Cape Fear River. During the 1976 run, one 12-year old female striped bass weighing approximately 20 kg (45 lbs) was taken by shad fishermen. Although no large individuals were observed during 1977, several smaller stripers (4-7 years old) were sampled from drift net catches.

Sturgeon

Sturgeon are not landed very often. They are caught primarily by shad fishermen and in haul seines. During February and March of 1976, two sturgeon were caught in shad nets. Both were in the 45.8 kg (100 lb) class. This suggests that a small spawning stock of sturgeon may exist in the river. Although no adult sturgeon were taken during 1977, shad fishermen did catch several small immature individuals in the lower portion of the Northeast Cape Fear River.

Tagging

During 1976, four striped bass and two Atlantic sturgeon were tagged, with no returns. They were released in the lower portion of the river and at Sanderson's seine.

During spring, 1977, four striped bass were tagged in the lower portion of the river and at Sanderson's seine. One 4-year old striped bass tagged 1 March 1977 in lower Smith Creek, was recaptured 34 days later in Sanderson's seine, an upstream movement of approximately 72 km.

Spawning Area Survey

Samples with 0.5 m plankton nets were routinely taken at the stations shown in Figure 5. In addition, random samples were taken where spawning was expected to occur. Druing 1977, special effort was made upstream (Crooms' Bridge to Limestone Creek) to locate American shad spawning areas.

American shad

Very little evidence of spawning by American shad was discovered. In 1976, only the immediate area around Sanderson's seine was found to be a spawning area (Table 17). During 1977, eggs, larvae and running-ripe females were found from below Lillington Creek to above NC 53 (Figure 29). Spawning probably occurs above Crooms' Bridge. The presence of adults and juveniles up to Limestone Creek indicates this area is probably a spawning area although no eggs or larvae were found.

Spawning was found to occur from the fourth week in March to the first week in May 1977 at water temperatures of 11-22°C (Figure 30).

River herring

River herring spawning was found to occur from mid-March to mid-May 1976, with peak spawning occuring at a water temperature of approximately 17°C. During spring, 1977, spawning occurred during March-April and May, with peak spawning at a water temperature of 18°C (Figure 31). Table 18 lists the evidence of spawning of river herring for the 1976-77 seasons. They were found to spawn from Crooms' Bridge to Long Creek and in the following tributaries: Long Creek, Turkey Creek, Prince George Creek, Island Creek, Harrison Creek, Merrick Creek, Pike Creek, and Burgaw Creek (Figure 32). Spawning activity was observed primarily in slough-swamp habitats adjacent to the main stream of the river. The current was probably too swift in the river itself to permit spawning.

Striped bass

Spawning of striped bass was found to occur from April to early May. Peak spawning both years was during April at water temperatures of approximately 19°C in 1976 and 18°C in 1977 (Figure 33). Table 19 lists the evidence of

TABLE 17.--Evidence of spawning of American shad, Northeast Cape Fear River, 1976-1977.

DATE	LOCATION	COMMENTS
3-18-76	River at Sanderson's seine	1 early stage egg captured
4-05-76	River at Sanderson's seine	1 running ripe female captured
4-20-76	River at Sanderson's seine	1 running ripe female captured
5-03-76	River at Sanderson's seine	1 running ripe female captured
3-22-77	River below Sanderson's seine	2 early stage and 1 late stage eggs captured
3-22-77	River at Sanderson's seine	1 prolarva captured
4-13-77	River above Lillington Creek	1 early stage egg captured
4-20-77	River above N C 53	1 running ripe female captured
4-22-77	River above Burgaw Creek	1 postlarva captured
4-27-77	River below Lillington Creek	1 late stage egg captured
5-04-77	River above Lillington Creek	1 early stage egg captured

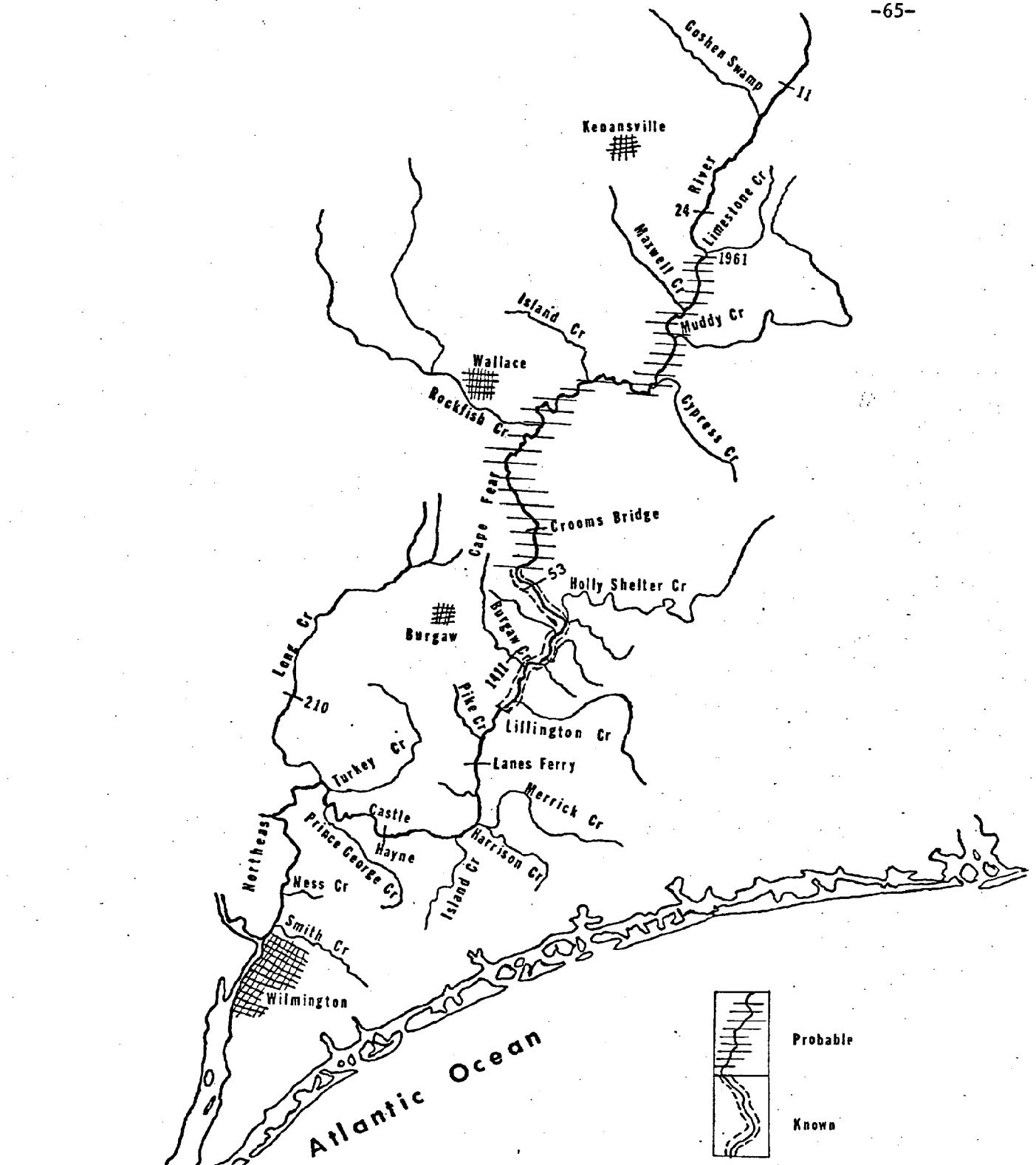


Figure 29.--Spawning areas of American shad, 1976-1977.

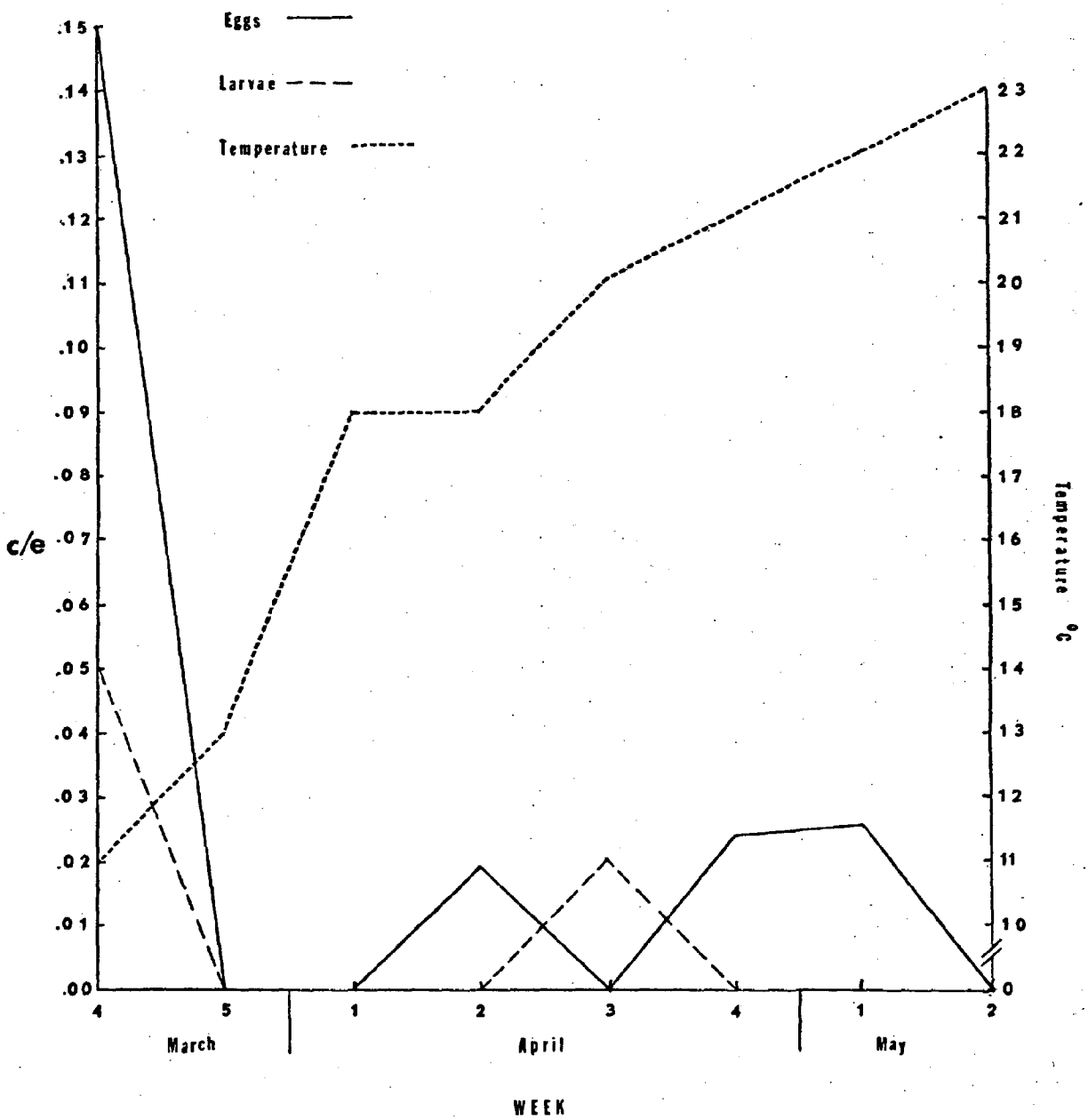


Figure 30.--Temperature and catch per effort of American shad eggs and larvae by week, Northeast Cape Fear River, 1977.

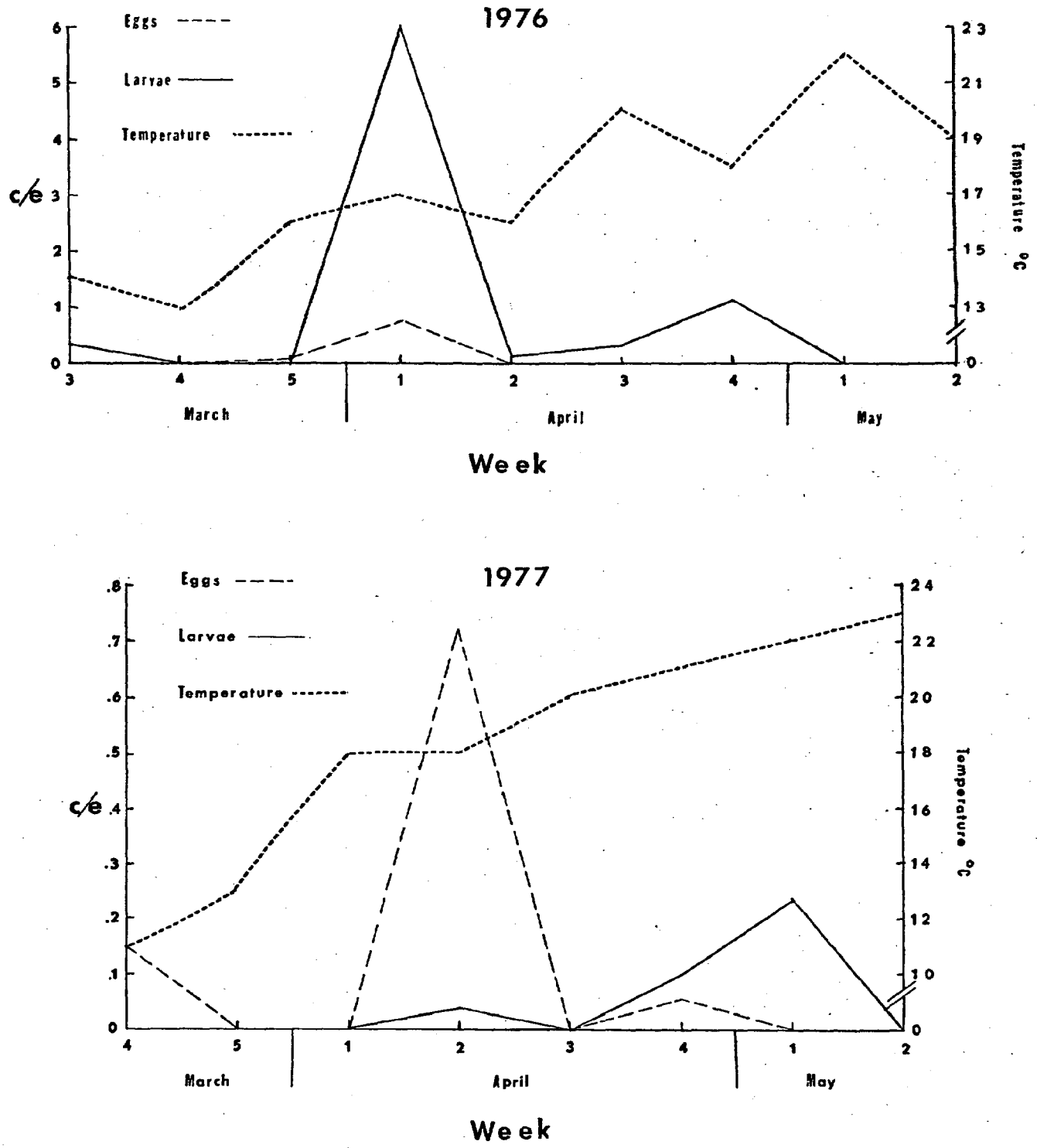


Figure 31.--Temperature and catch per effort of river herring eggs and larvae, Northeast Cape Fear River, 1976-1977.

TABLE 18.--Evidence of spawning of river herring, Northeast Cape Fear River, 1976-1977

DATE	LOCATION	COMMENTS
3-17-76	River at Turkey Creek	6 prolarvae captured
4-02-76	River below Croom's Bridge	1 early stage egg captured
4-08-76	River below Castle Hayne	3 running ripe female alewife captured
4-08-76	Turkey Creek	1 blueback herring postlarvae and 2 alewife postlarvae captured
4-08-76	Long Creek below 210	2 eggs and 15 prolarvae captured
4-13-76	Below Lane's Ferry	Visually observed spawning
4-13-76	Pike Creek	Visually observed spawning
4-14-76	Pike Creek	1 prolarva, 1 blueback postlarva and spawning visually observed
4-21-76	River at Turkey Creek	1 alewife postlarva captured
4-23-76	Below Lane's Ferry	1 alewife postlarva captured
4-23-76	Merrick Creek	3 blueback herring postlarvae captured
4-23-76	River at Harrison Creek	1 prolarva captured
4-23-76	Island Creek	1 prolarva captured
4-27-76	River above Pike Creek	3 prolarvae, 3 blueback postlarvae captured
4-27-76	River above Lillington Creek	6 prolarvae captured
4-29-76	Lower Long Creek	1 prolarva captured
4-29-76	Long Creek below 210	1 blueback postlarva captured
4-29-76	Prince George Creek	1 blueback postlarva captured
4-29-76	River above Castle Hayne	2 prolarvae captured
4-29-76	River below Harrison Creed	2 prolarvae, 3 blueback postlarvae and 1 alewife postlarva captured
4-29-76	Harrison Creek	4 prolarvae captured
5-11-76	Long Creek below 210	1 alewife postlarva captured
5-20-76	River at Sanderson's Seine	1 prolarva captured
5-20-76	Below Crooms' Bridge	1 blueback postlarva captured

TABLE 18.--Continued

DATE	LOCATION	COMMENTS
3-22-77	River below Sanderson's seine	1 early stage and 1 late stage egg captured
3-22-77	River at Sanderson's seine	1 early stage egg captured
4-06-77	Long Creek below 210	4 running ripe female bluebacks captured
4-13-77	Pike Creek	1 running ripe female blueback captured
4-13-77	River above Lillington Creek	36 early stage eggs captured
4-13-77	River at Burgaw Creek	2 prolarvae captured
4-14-77	Lower Burgaw Creek	5 running ripe female bluebacks captured
4-15-77	Long Creek below 210	1 early stage egg captured
4-18-77	River at Sanderson's seine	1 running ripe female blueback captured
4-20-77	River above 53	4 running ripe female blueback captured
4-27-77	Lower Pike Creek	1 prolarva captured
4-27-77	Lower Burgaw Creek	1 blueback postlarva captured
4-27-77	River below Lillington Creek	2 early stage eggs captured
4-27-77	River above Pike Creek	2 blueback postlarvae captured
5-04-77	Lower Merrick Creek	3 prolarvae and 6 blueback postlarvae captured

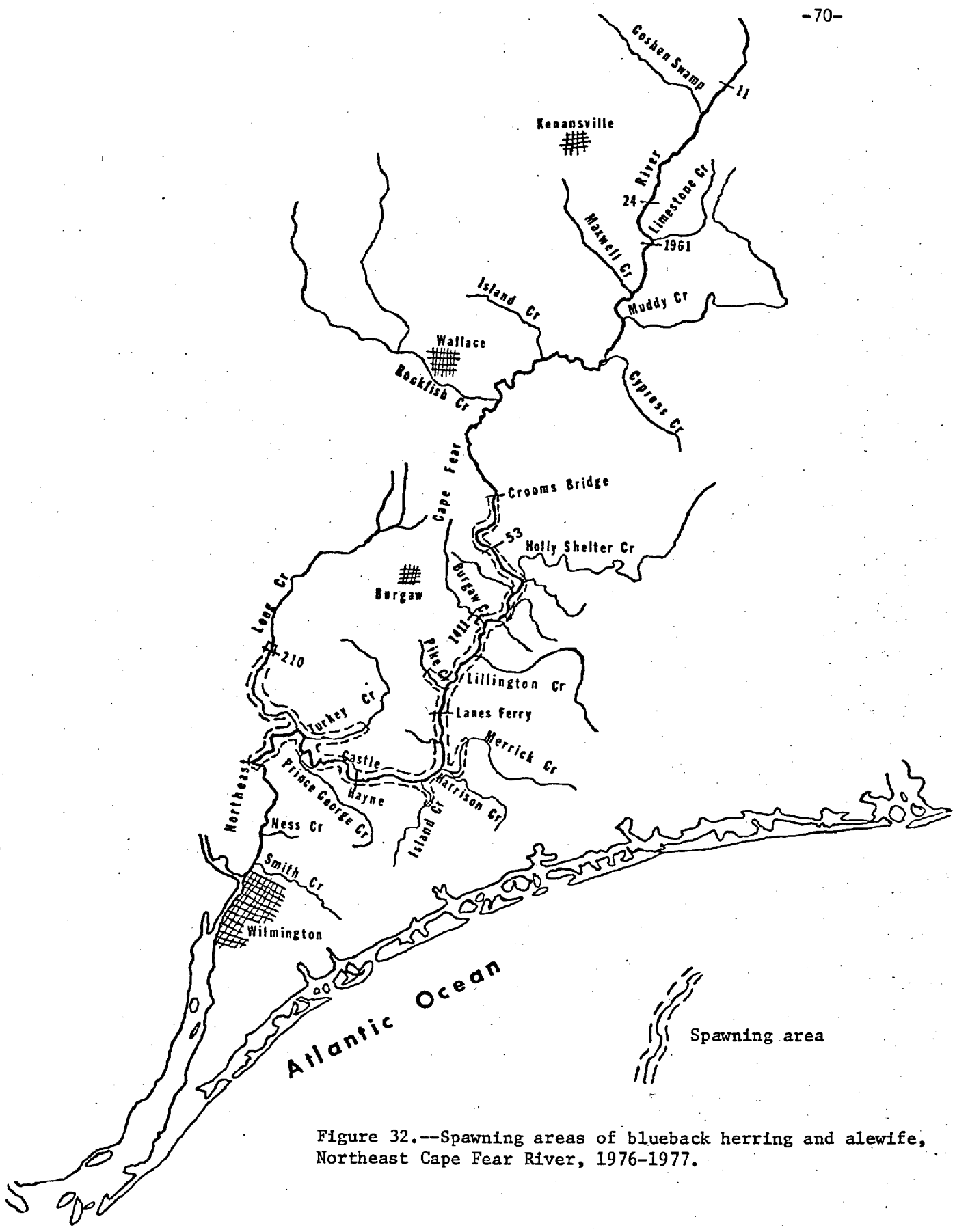


Figure 32.--Spawning areas of blueback herring and alewife, Northeast Cape Fear River, 1976-1977.

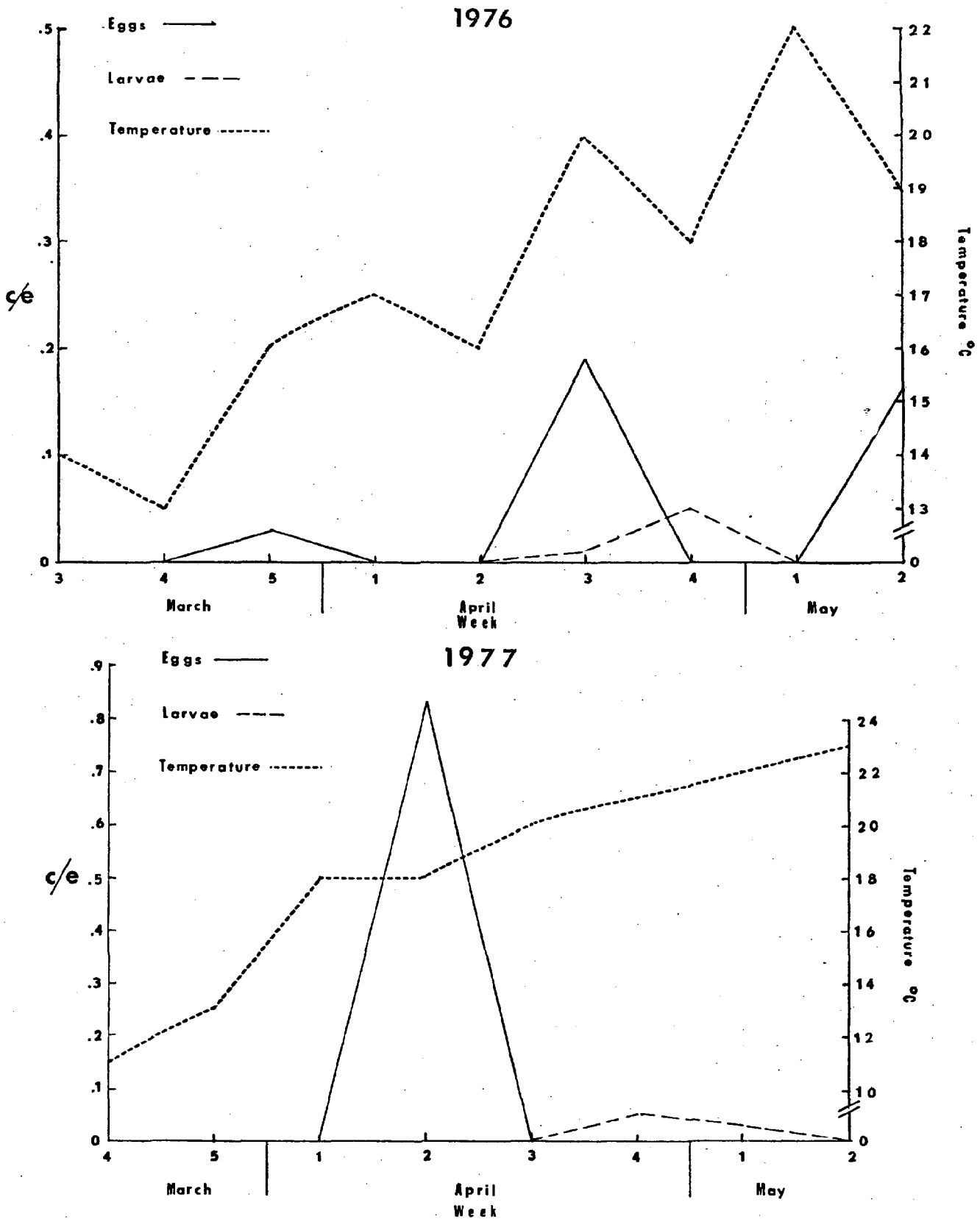


Figure 33.--Temperature and catch per effort of striped bass eggs and larvae, Northeast Cape Fear River, 1976-1977.

TABLE 19.--Evidence of spawning of striped bass, Northeast Cape Fear River, 1976-1977.

DATE	LOCATION	COMMENTS
4-2-76	Below Crooms Bridge	4 early stage eggs captured
4-21-76	River above Ness Creek	1 postlarva captured
4-23-76	River at Harrison Creek	4 early stage eggs captured
4-29-76	River below Harrison Creek	9 prolarvae and 1 postlarva captured
5-12-76	River at Turkey Creek	1 early stage egg captured
5-12-76	River below Castle Hayne	2 early stage eggs captured
4-13-77	River below Harrison Creek	14 early stage and 4 late stage eggs captured
4-13-77	River below Lane's Ferry	4 early stage eggs and 1 prolarva captured
4-15-77	Lower Long Creek	9 early stage eggs and 1 late stage eggs captured
4-15-77	River above Turkey Creek	4 early stage and 1 late stage eggs captured
4-15-77	Lower Prince George Creek	3 early stage and 1 late stage eggs captured
4-15-77	River below Castle Hayne	3 early stage eggs captured
4-18-77	River at Sanderson's seine	1 running ripe female captured
4-27-77	River above Ness Creek	2 prolarvae captured
5-02-77	Lower Long Creek	1 prolarva captured

striped bass spawning. They were found to spawn from Crooms' Bridge to Ness Creek (Figure 34). The greatest amount of spawning occurred below Lane's Ferry. This area is characterized by relatively high tidal currents which are necessary to keep striped bass eggs in suspension.

Hickory shad

During March and April 1977, two hickory shad eggs and one postlarva was captured from above Crooms' Bridge to above Burgaw Creek. Table 20 lists the evidence of spawning of hickory shad.

SUMMARY AND CONCLUSIONS

1. The nursery area for juvenile American shad was from SSR 1961 to the mouth of the river. The seaward migration occurred in September although some were found in the river until December. The C/e dropped drastically in 1976 compared to 1975.
2. The nursery area for juvenile blueback herring was from above Crooms' Bridge to the mouth of the river with the greatest concentrations in the tributaries. The seaward migration occurred during October and November. Juvenile bluebacks were significantly more abundant in 1976 than in 1975.
3. The nursery area for juvenile alewife was from NC 53 to the mouth including the tributaries. They remained in the river until November and were slightly more abundant in 1976 than in 1975.
4. Juvenile hickory shad were found during June of 1976 and 1977 from NC 53 to the mouth.
5. Juvenile striped bass were found infrequently from Lane's Ferry to the river mouth.
6. Five immature Atlantic sturgeon were found above Ness Creek indicating this to be a possible nursery area.
7. Significant runs of American shad, blueback herring, and alewife were found with lesser runs of hickory shad and striped bass.

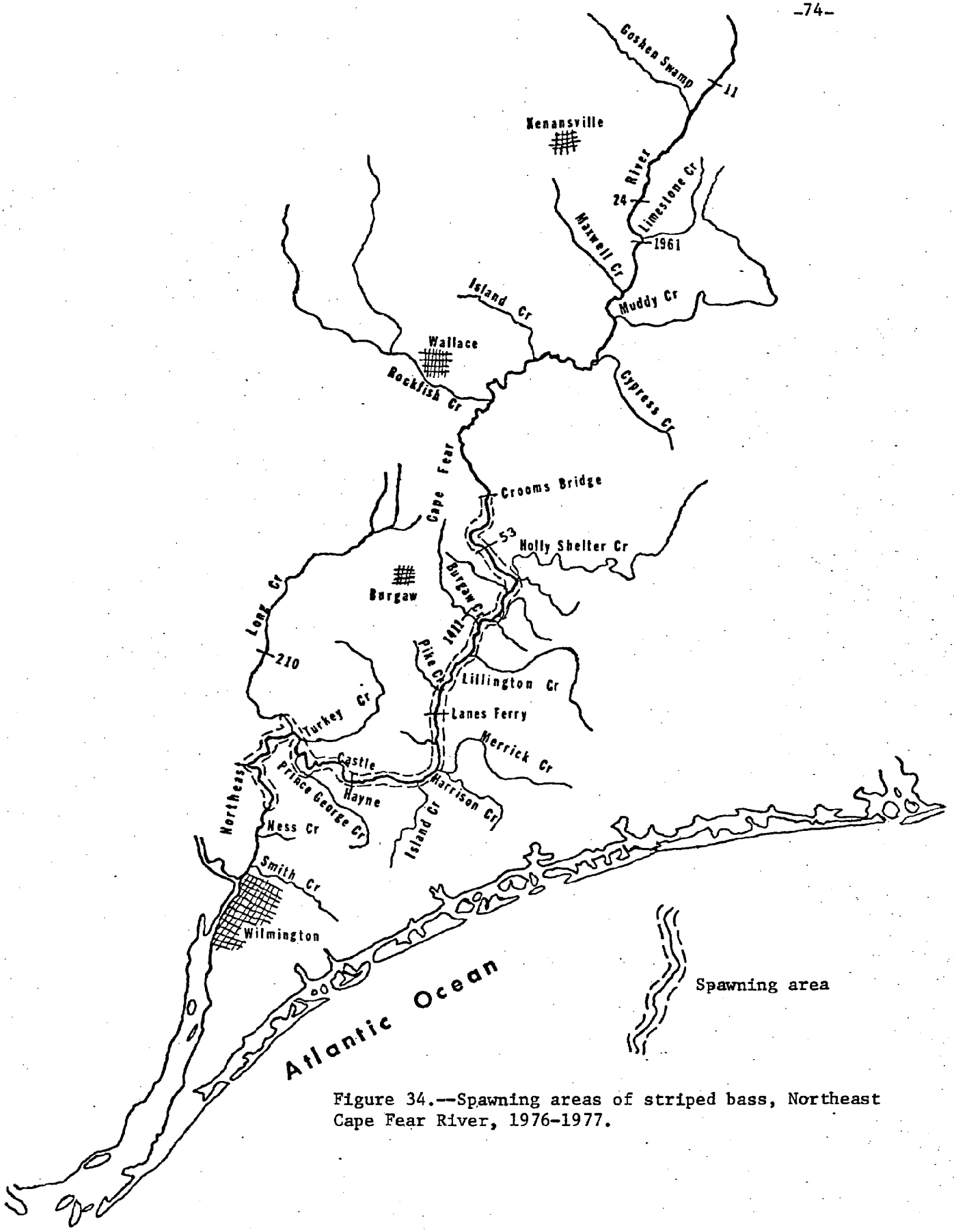


Figure 34.--Spawning areas of striped bass, Northeast Cape Fear River, 1976-1977.

TABLE 20.--Evidence of spawning of hickory shad, Northeast Cape Fear River, 1977.

DATE	LOCATION	COMMENTS
3-23-77	River above Crooms Bridge	1 early stage egg captured
4-13-77	River above Lillington Creek	1-provarva captured
4-13-77	River above Burgaw Creek	1 early stage egg capture

8. Haul seine samples produced American shad and blueback herring with fewer numbers of hickory shad, alewife, and striped bass.

9. Haul seine samples indicated the male:female sex ratio of American shad to be 4.7:1 in 1976 and 5.0:1 in 1977, possibly indicating that commercial and recreational fishing pressure on females was excessive.

10. American shad ranged from three to eight years of age. Five American shad were found to have spawning marks, the southernmost confirmed evidence of repeat spawning by American shad. All other American shad were virgins. The 1977 run is believed to have been greater than the 1976 run.

11. Blueback herring ranged from three to seven years in age, with only 16 percent showing evidence of prior spawning. The 1977 run was much greater than the 1976 run.

12. Alewife were from three to six years in age, with 91 percent being virgin. Adults were less abundant in 1977 than in 1976.

13. Hickory shad ranged from three to six years of age with 27 percent of the males repeating, and 23 percent of the females repeating.

14. Striped bass ranged from two to nine years of age.

15. Fishermen primarily harvested American shad with lesser amounts of river herring. Striped bass, hickory shad, and sturgeon were caught incidental to shad fishing.

16. The bulk of shad fishing was recreational, using drift gill nets and, to a lesser extent, anchored gill nets.

17. Five haul seines were operated during the 1976 and 1977 runs.

18. Gill net fishermen were fishing primarily for "roes". Unculled samples from these fishermen indicated a male-female sex ratio of 1.1:1 in 1976 and 0.4:1 male-female in 1977.

19. The season was shorter in 1977 (March and April), more fishing effort was expended, and good daily catches were reported, compared to 1976.

20. Fishing for river herring was very limited. Gill nets were set to capture herring for personal consumption and to bait fish traps. Ther greatest harvest of herring was by haul seine.

21. Three striped bass were tagged and none were returned in 1976. Of four striped bass tagged in 1977, one was returned from the haul seine 34 days later.

22. Two Atlantic sturgeon were tagged with no returns.

23. American shad were found to spawn from NC 53 to Lillington Creek during April.

24. River herring were found to spawn from Crooms' Bridge to Long Creek during March, April, and May.

25. Striped bass were found to spawn from Crooms' Bridge to Ness Creek from April through early May.

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LITERATURE CITED

Baker, W. D. 1968. A reconnaisance of anadromous fish runs into the Inland Fishing Waters of North Carolina. Final Report of Federal Aid in Fish Restoration, Project AFS-3. North Carolina Wildlife Resources Commission, 33p.

Bayless, Jack D. 1963. Survey and classification of the Northeast Cape Fear River and Tributaries, North Carolina. Final Report for Project F-14-R, Job I-E. North Carolina Wildlife Resources Commission, 12p. and appendix.

Beal, Kenneth Lee. 1968. Age and growth of the blueback herring (*Alosa aestivalis*) (Mitchill). M. S. Thesis, College of William and Mary, Williamsburg, Virginia, 82p.

Cating, James E. 1953. Determining age of Atlantic shad from their scales. U.S. Fish and Wildlife Service, Fishery Bulletin 54(84): 187-199.

Chambers, James Ross. 1969. Methods of distinguishing larval alewife from larval blueback herring. M.A. Thesis, College of William and Mary, Williamsburg, Virginia, 30p.

Cobb, John N. 1906. Investigations relative to the shad fisheries of North Carolina. North Carolina Geological Survey, Economic Paper No. 12, 39p.

Davis, James R. 1967. Sport fishing significance of anadromous shad runs. Final Report of Federal Aid in Fish Restoration, Project F-16-R. North Carolina Wildlife Resources Commission, 9p.

_____ and Randall P. Cheek. 1967. Distribution, food habits, and growth of young clupeids, Cape Fear River system, North Carolina. Proceedings of the 20th Annual Conference of the Southeastern Association of Game and Fish Commissioners, p. 250-260.

Godwin, Walter F. and John G. Adams. 1969. Young clupeids of the Altamaha River, Georgia. Georgia Game and Fish Commission, Marine Fisheries Division, Contribution Series No. 15, 30p.

Hassler, William W. and others. 1955-1976. Title varies. Mimeo reports, Zoology Department, North Carolina State University, Raleigh.

Holland, B. F., Jr. and George F. Yelverton. 1973. Distribution and biological studies of anadromous fishes offshore North Carolina. North Carolina Department of Natural and Economic Resources, Division of Commercial and Sport Fisheries, Special Scientific Report No. 24, 132p.

La Pointe, Donald F. 1958. Age and growth of the American shad, from three Atlantic coast rivers. Transactions of the American Fisheries Society, 87:139-150.

Lippson, Alice J. and R. Lynn Moran. 1974. Manual for identification of early developmental stages of fishes of the Potamac River estuary. Power plant siting program of the Maryland Department of Natural Resources, 282p.

Marcy, Barton C. 1969. Age determinations from scales of *Alosa pseudoharengus* (Wilson), and *Alosa aestivalis* (Mitchill) in Connecticut waters. M. S. Thesis, University of Connecticut, 26p.

Marshall, Michael D. 1976. Anadromous fisheries research program - Tar River, Pamlico River, and Northern Pamlico Sound. Completion report for Project AFCS-10, North Carolina Department of Natural and Economic Resources, Division of Marine Fisheries, 90p.

Nichols, Paul R. and Darrell E Louder. 1970. Upstream passage of anadromous fish through navigation locks and use of the stream for spawning and nursery habitat Cape Fear River, North Carolina 1962-1966. U.S. Fish and Wildlife Service, Circular 352, 12p.

Pate, Preston P., Jr. 1972. Life history aspects of the hickory shad, *Alosa mediocris* (Mitchill), in the Neuse River, North Carolina. M. S. Thesis, North Carolina State University, Raleigh, 67p.

_____. 1975. Anadromous fisheries research program - Tar River, Pamlico River, and Northern Pamlico Sound. Annual progress report for Project AFCS-10, North Carolina Department of Natural and Economic Resources, Division of Marine Fisheries, 69p.

Sholar, Terry M. 1975. Anadromous fisheries survey of the New and White Oak River systems. Final report for Project AFC-9, North Carolina Department of Natural and Economic Resources, Division of Marine Fisheries, 49p.

Stevenson, Charles H. 1899. The shad fisheries of the Atlantic coast of the United States. U. S. Commissioner of Fish and Fisheries, Report for 1898, Part 24, p. 101-269.

Street, Michael W. and John G. Adams. 1969. Aging of hickory shad and blueback herring in Georgia by the scale method. Georgia Game and Fish Commission, Marine Fisheries Division, Contribution Series No. 18, 13p.

_____ and Preston P. Pate, Jr. 1975. Anadromous fisheries research program. Northern coastal region, Section I. Final report for Project AFCS-8. North Carolina Department of Natural and Economic Resources, Division of Marine Fisheries, 173p.

Walburg, Charles H. 1957. Neuse River shad investigations, 1953. U. S. Fish and Wildlife Service, Special Scientific Report - Fisheries, No. 206, 13p.

_____ and P. R. Nichols. 1967. Biology and management of the American shad and status of the fisheries, Atlantic Coast of the United States, 1960. U. S. Fish and Wildlife Service, Special Scientific Report - Fisheries No. 550, 105p.

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